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Kennecott Utah Copper Corporation
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Kennecott

August 6, 2001

Tom Munson
UDNR – DOGM
1594 West North Temple
Suite 1210
Salt Lake City, Utah 84114

Re: KUCC South Facilities Final Remedial Design Work Plan

Dear TRC Member:

Please find attached, one copy of the KUCC South Facilities Final Remedial Design Work Plan. The draft work plan was revised according to comments from various TRC members. Copies of all written comments and KUCC responses are included in Appendix B of the Final Remedial Design Work Plan.

Please review the final work plan and provide any comments or concerns to Dr. Eva Hoffman (EPA Region VIII) within two weeks of receipt of the work plan. Dr. Hoffman has indicated that she will consider the work plan final two weeks from receipt of the document unless she receives overwhelming concerns about the plan.

If you have any questions about the work plan, please call me at 801-569-7128 or contact me via email at cherryj@kennecott.com.

Sincerely,

Jon Cherry, P.E.
Senior Project Engineer

Enclosure

Cc: TRC Members

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Final
South Facilities Groundwater
Remedial Design Work Plan

Prepared By: Kennecott Utah Copper
Date: August 6, 2001
Version C

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SOUTH FACILITIES GROUNDWATER
REMEDIAL DESIGN WORK PLAN

FINAL

Prepared by: Kennecott Utah Copper Corporation

Date: August 6, 2001

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1.0 INTRODUCTION

1.1 Purpose of Remedial Design Work Plan

This Work Plan sets out the technical basis, plans and schedules by which Kennecott Utah Copper Corporation (KUCC) will prepare a Final Remedial Design to address groundwater contamination at KUCC's South Facilities in accordance with (a) the U.S. Environmental Protection Agency's Record of Decision and (b) the State of Utah natural Resource Damage proposal and corresponding project agreements. The Remedial Design, which addresses the size, scope and character of the Remedial Action, will:

- describe the problems to be addressed
- identify the technical requirements to complete a successful remedial action
- establish performance-based criteria for the components of the remedy
- report the results of design investigations and support activities needed to finalize engineering plan
- report the results of investigations deferred to RD from the Feasibility Study stage, including:
  - *Effects of potential discharges on the Great Salt Lake*
  - *Characterization of extracted and treated water*
  - *Additional treatability studies*
  - *Containment and delivery system optimization*
  - *Additional modeling*
  - *Definition of delivery options*
  - *Delineation of institutional controls*
- present the engineering plans and specifications that implement the performance criteria
- document monitoring programs that will be implemented during and following remedial actions
- provide schedules for implementing the remedial action.

1.2 Site Description And Background

1.2.1 Study Area

The southwest Jordan Valley (SWJV) extends from the KUCC waste rock disposal areas on the eastern edge of the Oquirrh Mountains to the Jordan River. The foothills of the Traverse Mountains bound it on the south; the northern boundary is at approximately 7800 South Street. Figure 1-1 shows the project study area.

1.2.2 Site Description

The Bingham Canyon mine is located on the western edge of the SWJV in the Oquirrh Mountains. The open-pit mine covers 1,900 acres and is over one-half mile deep. More than five billion tons of rock have been removed from the pit, resulting in the production of more than 15 million tons of copper and other metals. Waste rock from the mine is placed along the east, west and north sides of the pit, where it is naturally leached by meteoric water. Prior to 2000, the waste rock was artificially leached with recycled acidic water. The active leaching circuit was discontinued on September 29, 2000.

1.3 Summary of Site Characteristics

This section summarizes the regional and site-specific geography, geology and hydrogeology as interpreted from previous site characterization studies and the RI field program. These topics are discussed in more detail in the RI report (KUC 1998a) and the FS report (1998b), which also include numerous figures and tables that document and elaborate the following discussion.

1.3.1 Geographic Setting

From the Oquirrh foothills to the Jordan River, the topography is of moderately low relief. Elevations of topographic features in the region range from 4,300 ft above mean sea level (amsl) at the Jordan River, 5,300 ft amsl along the foothills of the Oquirrh Mountains, to 9,000 ft amsl or more in the Oquirrh Mountains. The Jordan River enters the Jordan Valley through a gap in the Traverse Mountains referred to as the Jordan Narrows, and flows northward through the valley to the Great Salt Lake.

1.3.2 Meteorology

Climate. A wide range of temperatures, which are strongly influenced by altitude and topography, characterizes the climate of the Jordan Valley. Mean annual precipitation in the Jordan Valley is about 13 to 14 inches (Hely et al. 1971). Annual precipitation in the Oquirrh Mountains ranges from 20 to 40 inches, with the Bingham Canyon mine receiving an average of about 25 inches. Estimated annual potential evapotranspiration in the Oquirrh Mountains ranges from 21 to 27 inches, and in the Jordan Valley from 24 to 30 inches (Hely et al. 1971).

Surface Water Hydrology. The principal surface water in the SWJV is found in the Jordan River, Butterfield and Bingham creeks, and irrigation canals. Surface water recharge to the Jordan River consists of effluent from several sewage treatment plants, inflow from major tributaries, agricultural return flow to canals, and storm water and non-point-source runoff from numerous and various sources. North of the Jordan Narrows, groundwater inflow is the principal source of recharge to the Jordan River (Hely et al. 1971).

Butterfield and Bingham creeks are both intermittent, losing streams along their respective reaches in the basin fill of the SWJV (Dames & Moore 1988). Historically, the lower reaches of Butterfield and Bingham creeks have flowed only during peak runoff or major storm events, and have rarely reached the Jordan River. Butterfield Creek, which is the only stream in the area that is gauged, flowed at an average rate of 3.15 cubic feet per second (cfs) at the mouth of Butterfield Canyon between February 1998 and April 1999. The Herriman Irrigation Company uses the water from Butterfield Creek for irrigation. Surface water resulting from storm-water runoff in upper Bingham Creek is captured at the mouth of the canyon and used by KUCC in its process.

Four unlined irrigation canals (Provo Reservoir, Utah Lake Distributing, Utah and Salt Lake, and South Jordan) cross the eastern part of the SWJV. Water from these canals is used for irrigation and the latter three canals contain water only during the irrigation season. The Jordan River and Utah Lake are the source of water for all the canals except for the Provo Reservoir Canal, which receives some of its water from the Provo Reservoir and the remainder from Utah Lake.

1.3.3 Geology

Regional Geologic Setting. The Jordan Valley lies along the eastern margin of the Basin and Range physiographic province and is bounded on the east by the Wasatch Mountains, the south by the Traverse Mountains, the north by the Great Salt Lake, and the west by the Oquirrh Mountains. The western side of the Jordan Valley lies in a late Tertiary structural graben, which has been down dropped along mountain range-margin faults at the edge of the Oquirrh Mountains.

Basin and Range faulting produced uplift of the mountains surrounding the Jordan Valley during the Pliocene and Pleistocene. Subsequent erosion yielded unconsolidated to semi-consolidated deposits of clay, silt, sand, gravel and boulders, which were deposited in the SWJV. These deposits occur as pedimented alluvial fans along the front of the Traverse and Oquirrh mountains. In Late Pleistocene time, inundation of the Jordan Valley by Lake Bonneville resulted in lacustrine and shoreline deposits in the central part of the valley below an elevation of 5,200 ft amsl.

Site Geologic Setting. Based on previous studies and extensive subsurface investigations, six principal geologic units have been defined in the SWJV: Paleozoic bedrock, Tertiary volcanic rock, Jordan Narrows unit, alluvial fan and basin-fill deposits, Quaternary lacustrine deposits, and alluvium and colluvium. The distribution of these units is delineated by a series of geologic cross sections that were constructed across the study area (RI report, Appendix I). Descriptions of the units are presented in the RI report (KUC 1998a).

1.3.4 Hydrogeology

Interpretation of aquifer lithology and hydrologic properties is based on water levels, water quality, borehole geophysical logging and aquifer testing. These data were used to define hydrogeologic characteristics in the aquifer, hydraulic conductivity of aquifer materials, hydraulic gradients within the aquifer, groundwater flow directions and velocities, and water quality. A brief discussion of these properties follows; refer to the RI report Appendix F for more details. Unless otherwise noted, the source for all information on hydrogeology in this section is Appendix F of the RI.

Bedrock and Jordan Narrows Unit. In the SWJV, Paleozoic bedrock and Tertiary volcanic rock both provide recharge water to the principal aquifer. The Jordan Narrows unit, first encountered at the base of the principal aquifer about one mile east of the Oquirrh Mountains, is considered an aquitard and forms the base of the principal aquifer in the central portion of the SWJV. All of these units have relatively low hydraulic conductivity compared to the principal aquifer. However, the hydraulic conductivity of the Paleozoic bedrock and Tertiary volcanic rock is highly variable depending on the presence or absence of fractures.

Most of the groundwater flow in Paleozoic bedrock is probably through secondary fracture porosity. Hydraulic conductivity estimates range from 0.01 to 1.5 ft/day, but can be greater than 100 ft/day locally. In Tertiary volcanic rocks, groundwater flow is also likely confined to secondary permeability features such as fractures and lithologic contacts. The hydraulic conductivity of the volcanic bedrock ranges from 0.03 to 0.8 ft/day. There may be local movement of groundwater through the Jordan Narrows unit, which has a hydraulic conductivity of about 0.1 ft/day to 0.3 ft/day.

Principal Aquifer. The principal aquifer consists mainly of Plio-Pleistocene alluvial fan deposits of quartzitic and volcanic gravel. Estimates of hydraulic conductivity for volcanic gravel in the western part of the SWJV range from approximately 1 to 12 ft/day, whereas hydraulic conductivity is about 3 to 83 ft/day for quartzitic gravels. Vertical conductivity estimates for the principal aquifer range from 0.01 to 12 ft/day. The variation reflects differences in clay content within the volcanic and quartzitic gravels, and the presence of clay and silt interbeds.

Shallow Unconfined Aquifer. From the former KUCC evaporation ponds to the Jordan River, the principal aquifer is confined by a low permeability zone, and consists primarily of lacustrine deposits of gravel, silt and clay, and mixtures of these materials. The hydraulic conductivity of the shallow unconfined aquifer is typically low based on lithologic logs and slug testing estimates, but is also highly variable, as shown by Lambert (1995).

Groundwater Recharge. The principal aquifer is recharged from surface infiltration of precipitation, irrigation water and canal water, bedrock inflow, and to a limited extent from surface infiltration of waters emanating from Butterfield Creek. The bedrock of the Oquirrh Mountains provides recharge to the groundwater in the western part of the SWJV, and this groundwater then travels eastward into the basin. Aquifer recharge is greater in the eastern part of SWJV from canal seepage and in the Herriman area due to recharge from surface water.

Groundwater Extraction. Most of the water extracted from the principal aquifer is used for municipal or industrial purposes. The largest extractions in the study area are from the West Jordan and Riverton city well fields and KUCC process water wells. West Jordan City extracted an average of 6,012 afy from 1990-1996 (personal communication, West Jordan City 1996) but only 3,650 afy in 1999 and 2000 (West Jordan City, 2001). Riverton City extracted about 3,300 afy (Lambert 1995), but their extraction rose to 6,100 afy in 1999 (personal communication, Riverton City, 2000). KUCC production wells (K60 and K109) extract about 5,200 afy.

Groundwater Potentiometric Surface. The depth below ground surface to the potentiometric surface of the principal aquifer in the SWJV ranges from about 40 feet near the eastern front of the Oquirrh Mountains to over 400 feet in the center of the valley, approximately half way between the Oquirrh Mountains and the Jordan River. Between the former KUCC evaporation ponds and the Jordan River, the potentiometric surface of the shallow, unconfined aquifer ranges from 10 feet to 200 feet below ground surface. Groundwater flow is predominantly west to east from the base of the Oquirrh Mountains to the Jordan River. Groundwater in the principal aquifer near the Traverse Mountains generally flows to the northeast, changing to an easterly flow near the center of the basin.

Groundwater Elevation Changes. Groundwater elevations have declined between 2 and 3 feet per year through most of the SWJV over the past fifteen years. The greatest drop in water levels has been in the West Jordan City well field and the vicinity of the KUCC process-water wells. In these areas, the rate of decline averaged 4 to 8 feet per year between 1986 and 1996, but has slowed to about three feet per year since West Jordan City reduced pumping rates in 1996.

Water-levels along the eastern boundary of the KUCC waste rock disposal areas have fluctuated over the past decade by as much as 30 feet, depending on the location of the specific well. The observed water-level variations may be responses to changes in precipitation and recharge conditions, or they may reflect variations in leaching of the up-gradient waste rock. Leaching was discontinued in September 2000, so this variable in water-level responses now should be diminishing or even eliminated (Bingham Canyon Mine and Leach Collection System Groundwater Discharge Permit #UGW-350010-1999 Annual Report.

Ongoing groundwater monitoring by KUCC shows that water levels in the vicinity of the Large Bingham Reservoir and Lark have been stable (+/- 1 foot) from 1995 to 2000, during which time the Lark well has pumped an average of about 157 ac-ft per year. In the Acid Well (ECG1146) area, the water table is declining at about three feet per year. During 1996, the Acid Well pumped 71 ac-ft, in 1997 it pumped 223 ac-ft, in 1998 the total yield was 338 ac-ft, in 1999 it was 464 ac-ft, but in 2000 it was only 5 ac-ft. Higher withdrawals in the Acid Well area may be partially responsible for the localized water-level decline. It also is possible that the decline in this area is an extension of the large sink in the West Jordan municipal wellfield and the KUCC K60/109 area. .

The continued, overall decline of groundwater elevations in the most transmissive portions of the aquifer and the relatively rapid decline from 1991 to 1996, during the time of increased pumping from municipal well fields, indicate that more groundwater is being removed from the principal aquifer than is currently supplied by natural recharge.

Hydraulic Gradients. Horizontal hydraulic gradients in the SWJV vary considerably depending on the region. They are generally steeper near the mountains and shallower in the valley. Along a flow line from the Oquirrh Mountains to the Jordan River, the average composite horizontal hydraulic gradient is approximately 0.025.

Upward vertical hydraulic gradients are greatest near the base of the Oquirrh Mountains. Downward vertical gradients are present east of the Bingham Creek reservoir system and near the KUCC production wells. In the center of the western side of the basin (east of K60 and K109 to the former KUCC evaporation ponds), vertical hydraulic gradients are nearly non-existent. Both upward and downward gradients are found east of the former KUCC evaporation ponds, which reflects infiltration from canals and regional flow of groundwater to the Jordan River, respectively. Near the Jordan River, the vertical gradients are upward. Local variations in vertical gradients are also observed around municipal and KUCC well fields.

Groundwater Velocity. Average horizontal groundwater velocities were calculated using Darcy's Law, based on average gradients and hydraulic conductivity, and an effective porosity of 0.225, which is typical for gravel (Freeze and Cherry 1979). The overall, average linear groundwater velocity, based on a groundwater flow path from the Oquirrh Mountains to the Jordan River, is about 550 ft/yr (standard deviation of ± 525 ft/yr). This velocity assumes an average gradient of 0.025. In general, the average linear velocity of groundwater between the Oquirrh Mountains and Highway 111 is lower than farther east in the KUCC production well area. The lower velocity near the mountain front is due to lower hydraulic conductivity material (volcanic gravel) than in the production well area, which consists of quartzitic gravel.

Isotopic data, specifically tritium and CFCs (chlorofluorocarbons), also allow an estimate of average linear groundwater velocity to be made. In 1997, six CFC samples were collected along a flow line of the plume extending from the former Bingham Creek reservoir to the eastern edge of the plume (Solomon and Bowman 1997, Appendix K of RI report). Monitoring well P190A, located southeast of K60 just down gradient of the former Bingham Creek reservoir sulfate plume, yields a CFC-12 recharge age of 1961, which is consistent with the observed tritium activity in this well. The computed travel time from the Bingham Creek reservoir to P190A is 36 years, which yields an average linear groundwater velocity of about 500 ft/yr. Because dispersion (i.e., mechanical mixing of two fluids in the aquifer) could increase flow rates, this velocity may be in error by about 30 percent, suggesting a range in average groundwater velocity from 500 to 650 ft/yr.

The relatively large standard deviation (525 ft/yr) around the average linear groundwater velocity was derived by calculating theoretical velocities using all the hydraulic conductivity and gradient values determined during all of the aquifer tests done for the RI. Because the wells were located throughout the SWJV, in areas with a wide range of local hydraulic conductivities and gradients, the calculated values span a wide range. The calculated standard deviation can be interpreted as a measure of the precision of the calculation of a single, average linear velocity value, and shows that there are portions of the system in which flow is both slower and faster, as would be expected. The close correspondence between the hydraulic estimate of 500 ft/yr with the estimate of 500 – 6 50 ft/yr derived from the independent isotopic evaluation indicates that the average value is an accurate estimate for a system that is complex in detail.

1.4 Nature And Extent Of Contamination

Previous investigations and the RI report (KUC 1998a) have identified the following principal areas of mining-affected groundwater contamination: 1) down gradient and east of the Bingham reservoir system; 2) east of the former KUCC evaporation ponds; 3) Lark area; and 4) near the KUCC Eastside leach collection and containment system. Other, non-KUCC related mining related contamination also was identified in the area (e.g., ARCO Tailings). The nature and extent of contamination within each of the four principal areas of contamination are summarized below.

Bingham Creek Reservoir Area. Near the old Bingham Creek reservoir, the Bingham Creek groundwater plume is acidic and contains elevated concentrations of sulfate (averaging about 18,000 mg/L). Several metals occur at relatively high concentrations (and over a wide range of concentrations) within the Bingham Creek plume, including aluminum, arsenic, barium, cadmium, copper, iron, lead, manganese, nickel, selenium and zinc. Of these, aluminum (950 mg/L), copper (41 mg/L), iron (100 mg/L), manganese (350 mg/L), nickel (14 mg/L) and zinc (67 mg/L) are present at relatively high average concentrations, whereas arsenic, barium, cadmium, lead and selenium generally occur at average concentrations below 1 mg/L. Of these metals, only average concentrations of cadmium, copper, lead and zinc exceed their respective primary drinking water Maximum Contaminant Levels (MCLs) or action levels. Table 1-1 summarizes Zone A groundwater chemistry, based on data from the Acid Well (ECG1146), and lists State of Utah water quality standards also.

Table 1-1 Summary of Zone A Groundwater Quality

Element	Acid Plume Concentration[1]	Sulfate Plume Concentration[2]	Federal and State PRIMARY Drinking Water Standards	Federal and State SECONARY Drinking Water Standards
Alkalinity	< 10	186 - 216	-	-
Aluminum	4-750	<0.005	-	0.05-0.2
Arsenic	< .005 - 0.098	<0.005 - 0.007	0.05	-
Barium	<0.01 -0.022	0.024 - 0.095	2	-
Calcium	392 - 506	300 - 605	-	-
Cadmium	0.615 - 0.96	<0.001 - 0.001	0.005	-
Chloride	160 - 169	147 - 170	-	250
Chromium	<1	<0.01 - 0.015	0.1	-
Conductance, electrical	19,310 - 21,400	2160 - 3230	-	-
Copper	113-146	<0.02 - 0.03	1.3*	1
Fluoride	NA	0.2	4	2
Iron	430 - 631	<0.3	-	0.3
Lead	<0.005	<0.005	0.015*	-
Magnesium	4380 - 6700	84 - 170	-	-
Manganese	269 - 420	<0.01 - 0.017	-	0.05
Nickel	18.5 - 21.3	<0.4	0.1	-
Nitrate as Nitrogen	NA	1.2 - 1.5	10	-
pH	3.2-3.48	6.89 - 7.65	-	6.5-8.5
Potassium	10.5 - 11.9	2.9 - 4.3	-	-
Selenium	<0.002 - <0.2	0.002 - 0.018	0.05	-
Silver	<0.005 - <0.01	<0.001 - 0.001	-	0.1
Sodium	56 - 68	51 - 85	-	-
Sulfate	31,500 - 36,500	954 - 1940	500/1,000**[3]	250
Total Dissolved Solids	43,500 - 45,800	1750 - 2880	1,000/2,000[3]	500
Zinc	108 - 136	<0.01 - 0.018	-	5

Metals concentrations in plumes in dissolved concentrations. All others are total concentrations in mg/L.
NA Not Available
* Action Level
** Utah State standard only
[1] Range of concentrations in 4 samples collected from ECG1146 between 9/9/99 and 9/18/00 except Al, Ba, Fe,
Mn, Ni and Ag concentrations from 1998.
[2] Range of concentrations in 10 samples (5 from each well) collected from wells B2G1193 and K109 between
1/3/01 and 3/29/01 except F and NO_3 from 1994 and Ni from 1998-2000.
[3] If the concentration of sulfate is greater than 500 mg/L or TDS is greater than 1,000 mg/L, the supplier must
demonstrate that no better quality water is available and that the water shall not be available for human consumption at commercial establishments. In no case shall sulfate exceed 1,000 mg/L.
Source: Utah Administrative Code Rule R309-103 effective July 1, 2001.

Sulfate is the most widespread contaminant related to mining activities in the SWJV. As shown in groundwater quality maps in the RI and FS (Figure 1-2), the sulfate plume associated with the Bingham Creek reservoirs is readily apparent east of the reservoirs as an elongate-shaped zone oriented in a southeasterly to easterly direction. The leading edge of the highly concentrated interior of the plume (as defined by sulfate greater than 20,000 mg/L) has migrated approximately 10,200 ft since the reservoirs were placed in operation in 1965. The aerial extent of the Bingham Creek plume, as defined by the 1,500-mg/L-sulfate contour is about 16,000 feet long and its widest point is approximately 11,900 ft. The total area of the 1,500 mg/L contour covers about 2,950 acres (4.6 square miles) and is generally within KUCC property boundaries.

The concentration of sulfate in the Bingham Creek plume area varies vertically as well as horizontally. The volume of elevated sulfate groundwater is greatest in the first 150 feet of the aquifer, although the volume of highly elevated sulfate (i.e., greater than 20,000 mg/L) is larger in the zone from 150 to 300 feet below the water table.

The sulfate plume thins and narrows eastward. The greatest vertical extent of sulfate occurs beneath the heart of the plume, where sulfate at concentrations greater than 20,000 mg/L is present at the base of the principal aquifer, more than 650 ft below the water table. The average thickness of the sulfate plume is approximately 300 to 350 ft. Most contaminant plumes with a source at the surface generally tend to be relatively shallow, narrow and extended in the direction of groundwater flow, particularly where horizontal hydraulic gradients are high (Freeze and Cherry 1979). The Bingham Creek plume has spread more than 650 feet below the water table in an area where some of the highest horizontal gradients are present. The acidic, high-TDS plume water has a density that is approximately 4% greater than that of fresh water. The combination of the higher density and the mounding of the water table caused by leakage from the Bingham Creek reservoir during plume formation likely are part of the reason for the downward migration of the high-sulfate water. In addition, the dip of sedimentary layers in the alluvial fan sediments may impart an anisotropy to flow that leads to downward-directed flow.

The distribution of acidic groundwater (pH of less than 4.5) in the Bingham Creek plume is generally similar to that of sulfate at concentrations greater than 15,000 to 20,000 mg/L. Outside of the Bingham Creek plume (and isolated areas along the Eastside collection system), groundwater is generally neutral, with pH ranging from greater than 6.5 to near 8.0, and sulfate concentrations below 1,500 mg/L. The most acidic water (pH less than 3.5) has migrated about 10,000 ft since 1965. Within the heart of the plume, groundwater with pH of less than 4.5 also has penetrated to a depth of more than 650 feet below the water table.

Former KUCC (South Jordan) Evaporation Ponds Area. In mining-affected groundwater east of the evaporation ponds, elevated concentrations of sulfate, magnesium and TDS are indicators of mining-related contamination. There are currently no elevated metal concentrations associated with mining-affected groundwater in this area. The average concentrations of metals with primary drinking water MCLs are all below their respective standards in groundwater east of the evaporation ponds. The metals that are present in the groundwater in this area are most likely the result of recharge of surface irrigation water and leakage from the four canals that traverse the area (SMI 1996).

Compared to the Bingham Creek plume, sulfate and other constituents occur at much lower concentrations in the area of the former evaporation ponds. Most of the groundwater east of the former KUCC evaporation ponds contains sulfate at less than 1,500 mg/L, with only isolated areas exhibiting concentrations greater than this value. The average concentration of sulfate east of the former KUCC evaporation ponds is 683 mg/L; TDS is 1,748 mg/L.

The pH distribution in this part of the SWJV is essentially neutral, indicating that any acidic water that may have recharged the aquifer has been neutralized, most likely through reactions with carbonate minerals in the aquifer matrix. Isolated areas of pH less than 6.5 are probably due to the natural variation in pH resulting from natural processes in groundwater systems, because these areas do not correspond spatially to areas of elevated sulfate, as is seen in the area of the Bingham Creek Reservoir plume (SMI 1996).

Lark Area. Water flowing from underground workings and seepage of waste rock leachate has produced an area of contaminated groundwater in the Lark area (i.e., east of the old town of Lark and near and down gradient of the Lark tailings area). Groundwater contamination in this area is shallow and less concentrated than groundwater in the Bingham Creek plume. Sulfate concentrations in mining-affected groundwater average 920 mg/L and TDS averages 2,000 mg/L.

Groundwater in the Lark area is essentially neutral, with only isolated areas containing groundwater with pH less than 6.5. Metal concentrations are low; only cadmium has been measured in mining-affected groundwater at an average concentration slightly greater than its MCL.

Most of the sulfate- and TDS-contaminated groundwater in the Lark area occurs within the upper 300 feet of the aquifer, as do the local zones in which pH is less than 6.5. Beneath this zone of contamination, the quality of the groundwater is good (constituents occur at background concentrations). KUCC installed a well (LTG1139) in the deeper aquifer to demonstrate the production of high quality water.

KUCC Eastside Collection System Area. The Bingham Canyon Mine waste rock disposal areas have been actively leached for copper since 1913. In the past, some leachate generated by these activities escaped the KUCC capture system, resulting in contamination of the groundwater immediately down gradient from the waste rock. In 1996, KUCC significantly upgraded the leachate collection and containment system along the waste rock areas. This reduced the contribution of waste rock as a source of contamination to the principal aquifer by cutting off flow along the surface and in alluvium at the toe of the waste rock dumps. Active leaching stopped in September 2000, and the collection system has shown a rapid reduction of flow volumes, returning to meteoric flow values.

The mining-affected groundwater is generally shallow here, and occurs mostly in a relatively thin veneer (0 to 70 ft saturated thickness) of volcanic gravel or quartzitic gravel alluvium above volcanic bedrock. Water quality of groundwater along the waste rock areas is variable, with sulfate concentrations ranging from 42 mg/L to 22,400 mg/L, averaging 3,900 mg/L. TDS content is similar, with concentrations ranging from 376 mg/L to 27,000 mg/L, averaging 5,900 mg/L. Relatively high concentrations of sulfate correspond with depressed values of pH. For metals with primary drinking water standards, cadmium (0.11 mg/L), copper (24 mg/L) and lead (0.017 mg/L) averaged above their respective primary MCLs or action levels.

Elevated concentrations of sulfate and TDS occur in isolated areas, typically within surface water drainages along the toe of the waste rock. The maximum sulfate concentration in the area, at well P244A, decreased from 22,400 to 4,730 mg/L from 1994 to 2000.

1.5 Description of Selected Remedy

To ensure compatibility, this section is taken verbatim from the U.S. Environmental Protection Agency's Record of Decision.

> "The selected remedy for Operable Unit 2 (Southwest Jordan River Valley Ground Water Plumes) addresses the ground water contamination for this KUCC South Zone Site. The surface contamination, which originally constituted the principal threat at the site, has already been addressed in other removal and remedial actions at OU1 (Bingham Creek), OU3 (Butterfield Creek), OU4 (Large Bingham Reservoir), OU5 (ARCO Tails), OU6 (Lark Tailings and Waste Rock), OU7 (South Jordan Evaporation Ponds), OU10 (Copperton Soils), and OU17 (Bastian Area).
>
> "For purposes of clarifying agency authority over the cleanup operations of this action, the agencies plan on using a joint CERCLA and State NRD approach. The cleanup strategy presented within the text of this ROD is concerned primarily with the acid plume in Zone A, under CERCLA authority. EPA maintains the right to intervene in the cleanup of the sulfate plume in Zone B, if

it is not addressed sufficiently by the State NRD action. The State of Utah will maintain authority of operations, in both Zones A and B, as they are intended to fulfill the requirements of the NRD settlement.

"The performance standards for the selected remedy include achieving the primary drinking water standards in the aquifer of Zone A at the KUCC property line (as of the date of the signing of this document) for all hazardous substances (i.e. metals). Active remediation (pump and treat) is required to achieve the health-based goal of 1500 ppm for sulfate while monitored natural attenuation is used to achieve the State of Utah primary drinking water standard for sulfate at 500 ppm. The water treated and delivered for municipal use must achieve all drinking water standards of the State of Utah, as a requirement of both the CERCLA action and the Natural Resource Damage (NRD) settlement between the State of Utah and KUCC. The performance standard for treatment residuals as measured at or before the end of the tailings pipe is demonstration that the tailings/treatment residuals combination meets the characteristics of non-hazardous waste.

"The selected remedy involves treatment and containment of contaminated ground water plumes. The principal threats, which caused the groundwater contamination, have been addressed in previous actions or are contained under provisions of a Utah Ground Water Protection Permit.

"The selected remedy contains the following elements:

- Continuation of source control measures as administered through the State of Utah Ground Water Protection Program.

- Prevent human exposure to unacceptably high concentrations of hazardous substances and/or pollutants or contaminants by limiting access to the contaminated ground water. Institutional controls include purchases of land, purchases of water rights, limiting drilling of new wells and increased pumping of nearby old wells as approved (on request) and administered through the State of Utah State Engineer (Division of Water Rights).

- Prevent human exposure to unacceptably high concentrations of hazardous substances and/or pollutants or contaminants through point-of-use management which includes providing in-house treatment units to residents with impacted wells, replacement of their water by hooking the properties up to municipal drinking and/or secondary supplies, and/or modifying their wells to reach uncontaminated waters.

- Contain the acid plume in Zone A by installation of barrier wells at the leading edge of the contamination (1500 ppm sulfate or less), pump and treat the waters to provide a hydraulic barrier to further plume movement while providing treated water for municipal use. The treatment technology for the barrier well waters is reverse osmosis.

- Withdraw the heavily contaminated waters from the core of the acid plume in Zone A and treat these contaminated waters using pretreatment with nanofiltration or equivalent technology, followed by treatment with reverse osmosis to provide drinking quality water for municipal use.

- Monitor the plume to follow the progress of natural attenuation for the portions of the Zone A plume which contain sulfate in excess of the state primary drinking water standard for sulfate (500 ppm sulfate).

- Disposal of treatment concentrates in existing pipeline used to slurry tailings to a tailings impoundment prior to mine closure.

- Development of a post-mine closure plan to handle treatment residuals for use when the mine and mill are no longer operating.

"Statutory Determinations

"The selected remedy is protective of human health and the environment, complies with Federal and State requirements that are applicable or relevant and appropriate to the remedial action, is cost-effective, and utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable.

"This remedy also satisfies the statutory preference for treatment as a principal element of the remedy (i.e., reduces the toxicity, mobility, or volume of hazardous substances, pollutants, or contaminants as a principal element through treatment).

"Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five years after initiation of remedial action to ensure the remedy is, or will be, protective of human health and the environment."

1.6 Preliminary Failure Modes and Effects Analysis (FMEA) for Remedial Design

Based on the findings of the Record of Decision, the purpose of the Remedial Design (RD) is to develop and document the technical requirements of the Remedial Action that will be executed by KUCC to resolve the CERCLA issues associated with contamination of groundwater from mining activities associated with the South Facilities of the Bingham Canyon mining complex. The general nature of the selected remedy and an overview of the conceptual design for that remedy have been presented in Sections 1.4 and 1.5, above.

The scope of the RD includes engineering plans for three "functional units" of the conceptual plan:

- Groundwater containment and extraction system;
- Water treatment (NF and RO) and hydraulic delivery system for treated water and concentrate
- Treatment of acid-plume (NF) and Zone A (RO) concentrates

As with most CERCLA actions, the RI/FS phase did not produce all the data needed for the Remedial Design. To determine the sorts of information needs that are most critical to successful performance of the selected remedy, KUCC consulted its design team to identify gaps in support information and underlying data. In addition, KUCC elected to use a style of engineering risk assessment called "Failure Modes and Effects Analysis" (FMEA). FMEA is a qualitative evaluation that uses experienced specialists to describe an engineered system in terms of its critical components. Using this description of the system and its components, the specialists then systematically identify (a) ways in which adverse effects could arise; (b) the severity of the consequence(s) of those effects; and (c) how the project could mitigate the adverse effects. This preliminary FMEA is organized with respect to the three functional units of the conceptual plan.

The FMEA process allows the project team to concentrate on the information needed to control risk in the components and the overall system. It provides a traceable rationale for the identification of data needs, and therefore for the studies and projects needed to resolve the remaining, known uncertainties. The preliminary FMEA for this project is summarized in Table 1-1, and the results of this evaluation are used in Section 3.0 Technical Scope of Work to formulate the design investigations and design-support activities that are the principal subject of this Work Plan.

Table 1-2 Summary of Preliminary Failure Modes and Effects Analysis
(RD Work Plan Section 1.6)

FAILURE MODE	ADVERSE EFFECT	RANK OF CONSEQUENCE	POSSIBLE MITIGATION
Groundwater Collection and Containment System			
Well Casing Fails Above Plume	1. Acidic or high-SO4 water flows to vadose zone and re-infiltrates 2. Extraction rate compromised	1. Low: re-infiltration local to existing plume 2. Low to Moderate, depending on amount of flow lost	1. Plug and redrill well 2. Sleeve well
Extraction rate does not contain plume	1. Plume is not contained; water quality degrades downgradient	1. High to Extreme	1. Reconfigure pumping 2. Increase extraction rates 3. Install and pump additional wells 4. Add injection wells to improve containment
Extraction rate creates overdraft on aquifer	1. Rate of water-level decline exceeds State Engineer's guidelines	1. Moderate (e.g., adjust pumping rates) to severe (e.g., adverse impacts to water rights or ground subsidence)	1. Monitor water levels against predictions and adjust pumping as necessary; 2. Respond to direction from State Engineer 3. Add injection wells to improve containment
Feed-water pipeline fails	1. Contaminated water spills to surface 2. Delivery rate to water treatment (NF and RO units) is compromised	1. Low and local if quickly contained. Could be moderate to high if unidentified for long period 2. Low to moderate, depending on volume and period of interruption	1. Place pipelines above ground for inspection 2. Locate pipelines hydraulically up-gradient of extraction wells. 3. Monitor flow rates and shut down flow automatically if rate falls out of control 4. Double-wall (or otherwise contain) pipelines 5. Leak detection in double-wall, with failsafe 6. Storage during repairs or shut down pumping

FAILURE MODE	ADVERSE EFFECT	RANK OF CONSEQUENCE	POSSIBLE MITIGATION
Water Treatment (NF and RO) and Hydraulic Delivery Systems			
Larger volumes than anticipated require treatment and distribution	1. Capacity must be increased 2. Rate of aquifer clean-up compromised	1. Low (technical) to moderate (cost) 2. Moderate to high, depending on scale of modification to schedule	1. Add additional treatment and/or delivery capacity 2. Add additional transmission capacity for potable water
Quality of extracted water degrades beyond requirements of RO feed water	1. Increased feed pressure 2. Lower permeate recovery and quality	1. Low (technical) to moderate (cost)	1. Blend with low-TDS water 2. Use nanofiltration or other treatment
Concentrate pipeline fails	1. Contaminated water spills to surface 2. Delivery rate to Copperton tailings line compromised	1. Low and local if quickly contained. Could be moderate to high if unidentified for long period 2. Low	1. Place pipelines above ground for inspection 2. Place pipelines up-gradient of extraction system 3. Monitor flow rates and shut down flow automatically if rate falls out of control 4. Double-wall (or otherwise contain) pipelines 5. Provide temporary storage (e.g., Desilting Basin) while pipeline is repaired
Permeate pipeline fails	1. Clean water delivery interrupted 2. Regulatory impact for drinking water supplies	1. Low to moderate	1. Restore flow 2. Provide alternative fresh water through purchase or alternative source
Treatment works unavailable due to unscheduled maintenance or system (e.g., power supply) failure	1. Treatment unavailable or curtailed	1. Low (if interruption is short) to Moderate	1. Curtail pumping 2. Store water in KUCC lined reservoirs 3. Accelerate repairs 4. Consider redundancies

FAILURE MODE	ADVERSE EFFECT	RANK OF CONSEQUENCE	POSSIBLE MITIGATION
Treatment of Water-Treatment Concentrates in KUCC Tailings Circuit			
Mechanical failure of tailings pipeline	1. Contaminated water and solids spill to surface 2. Groundwater extraction and treatment rates compromised; 3. Copper production curtailed	1. Low and local if quickly contained; could be moderate to high if unidentified for long period 2. Low to high, depending on volume and period of interruption 3. Moderate to extreme, depending on length of curtailment	1. Inspect and maintain 2. Monitor flow rates and shut down flow automatically if rate falls out of control [NB: Very difficult technically] 3. Store concentrates (e.g., in Desilting Basin) until tailings flow restored
Pipeline scale affects performance	1. Scale adversely affects pipeline performance or maintenance schedule	1. Low (technical) to moderate (cost)	1. Control scale by chemical management or physical removal
Tailings circuit does not adequately control chemistry	1. Chemistry of decant pool exceeds discharge criteria 2. Chemistry of return flow exceeds processing criteria	1. Moderate if system recovers quickly; high if prolonged. 2. High to very high	1. Control discharge, or treat decant pool, if a short-term problem 2. Adjust chemistry of process-water, if a short-term problem 3. Blend with gray water (or other waters) 4. Long-term mitigation currently undefined
Metals and metalloids not irreversibly removed in tailings solids	1. Adverse water-quality impacts to discharge	1. Low (if reversibility is low) to very high	1. Long-term mitigation currently undefined

FAILURE MODE	ADVERSE EFFECT	RANK OF CONSEQUENCE	POSSIBLE MITIGATION
Treatment of Water-Treatment Concentrate in KUCC Tailings Circuit (con.)			
Tailings acidified	1. Adverse water quality impacts to GW and SW discharge 2. Adverse impacts to surface reclamation 3. Regulatory & permitting impacts	1. Moderate (if acidity, metals fluxes are low) to extreme	1. Long-term mitigation currently undefined 2. Re-vegetate with resistant species; soil amendments to control phytotoxicity
Water quality not suitable for discharge to GSL at end of mining	1. Alternative for water and chemical management required	1. Moderate (if flow volumes and chemistry are moderate) to extreme	1. Evaporation with "RCRA" containment for solids 2. "Land application", if concentrations do not exceed regulatory limits

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

The overall organization of the project team for the remedial design phase and its relationship to EPA and UDEQ oversight is shown in Figure 2-1. The specific responsibilities of each individual or group are discussed below.

2.1 KUCC Personnel

Mr. Jon Cherry, P.E., will be the KUCC Project Manager and main point of contact for communications to and from KUCC. Mr. Cherry is designated as the Design Professional for this program. Mr. Cherry will be responsible for day-to-day communication with the EPA and UDEQ oversight as well as with contractors and consultants hired for specific tasks. His general responsibilities include implementation of a remedial design that will meet the performance criteria specified December 13, 2000 Record of Decision (ROD). As project manager, Mr. Cherry will define and clarify the scope of work and objectives for each major activity, and then he ensure the technical, budget, permitting and schedule requirements are met. Mr. Cherry is a registered professional engineer with over ten years of RCRA, CERCLA, SARA, and environmental permitting and compliance experience.

Mr. Bart Van Dyken is the KUCC Director of Engineering Services and will oversee the design, construction and operation of the extraction and treatment facilities. He will be responsible for coordinating the necessary resources to accomplish the design of the various elements and to complete the remedial design phase on schedule. Mr. Van Dyken and his staff will be responsible for the design, documentation, procurement, accounting and construction management of the containment/extraction wells, delivery of the extracted water to the Nano-Filtration (NF) and Reverse Osmosis (RO) treatment plants and delivery of the treated waters and concentrate streams to water suppliers and the tailings line, respectively. Mr. Van Dyken has over 25 years of engineering experience in large-scale production and environmental remediation projects.

2.2 Consultants/Contractors

Mr. Helmar Bayer is the president of HBC International, Inc. and has contracted to KUCC for the past 10 for treatability testing and design of the nanofiltration and reverse osmosis treatment plants. Mr. Bayer will continue in this capacity, working directly with KUCC Engineering Services, to design, construct and operate the treatment facilities. Mr. Bayer holds a M.S. in food and fermentation technology and has over ten years experience in wastewater treatment design.

Mark Logsdon is principal geochemist and president of Geochimica, Inc. and has contracted to KUCC to perform specific geochemical investigations related to the remedial design as well as provide other technical oversight throughout the remedial design process. Mr. Logsdon holds a M.S. in geology with specialization in geochemistry, has published numerous articles on specific geochemical issues and is a recognized expert in his field, with more than 25 years experience in mining-related geochemical studies.

Brian Vinton is president of North American Mine Services (NAMS). Mr. Vinton and his staff of engineers and technicians have contracted to KUCC over the past ten years for source removal/control projects and RIFS. Mr. Vinton holds a B.S. in earth science and has over 20 years of experience in the exploration, mining and environmental remediation fields. NAMS is contracted to KUCC as part of the remedial design project to provide technical review, GIS support, groundwater modeling, groundwater data management and source control evaluation.

2.3 Government Oversight: EPA/UDEQ

Dr. Eva Hoffman is the Remedial Project Manager (RPM) from EPA Region VIII for the remedial design. Dr. Hoffman has been the EPA lead project manager for this project during the source removal/control projects and RIFS and will be responsible for coordination of all oversight for the project from EPA's perspective. She also will be responsible for contracting technical support and review from the U.S. Army Corps of Engineers and United State Geological Survey (USGS) to support her oversight role. Dr. Hoffman's responsibilities include ensuring that the remedial design will meet the performance criteria established in the ROD, that the public's interests are protected and that all federal administrative requirements are met.

Mr. Doug Bacon will be the lead project manager from the State of Utah Department of Environmental Quality (UDEQ) for the remedial design phase of this project. Mr. Bacon was the lead project manager for UDEQ during the FS and ROD. Mr. Bacon will be responsible for coordination of all oversight for the project from UDEQ's perspective and ensuring that all State administrative requirements are met.

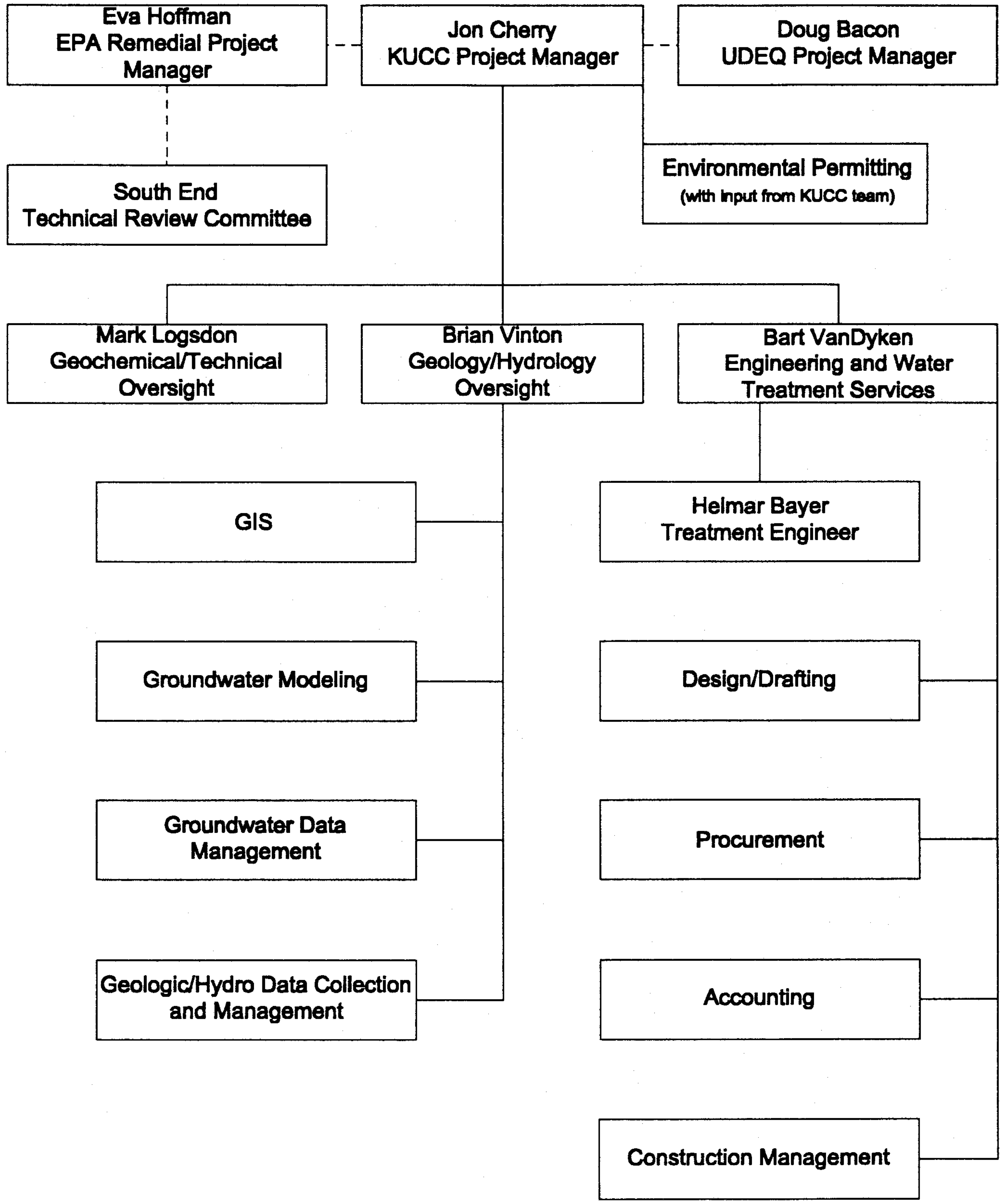
2.4 Technical Review Committee (TRC)

The TRC was formed during the initial stages of the RI and has continued through the FS and into the remedial design. The committee is comprised of representatives from Kennecott, various federal, state and local government agencies, as well as, representatives from local municipalities and local residents. The TRC is co-chaired by the KUCC, EPA and UDEQ project managers. There are two purposes of the TRC. First the TRC provides a forum in which the technical details and progress of the remedial design can be communicated in a transparent process that allows open dialog between the interested parties. The second purpose of the TRC is to provide technical review in their respective areas of expertise to ensure that basic assumptions are credible and critical details are not overlooked. Table 2-1 is current listing of TRC members, their affiliation, phone number and email address.

Table 2-1 South Facilities Technical Review Committee

	NAME	AFFILIATION	PHONE NUMBER	*EMAIL*
1	Eva Hoffman	EPA	303-312-6764	Hoffman.eva@epamail.epa.gov
2	Helen Dawson	EPA	303-312-7841	Dawson.helen@epamail.epa.gov
3	Brent Everett	UDEQ – DERR	801-536-4171	Beverett@deq.state.ut.us
4	Doug Bacon	UDEQ – DERR	801-536-4282	Dbacon@deq.state.ut.us
5	Dennis Frederick	UDEQ – DWQ	801-538-6038	Dfrederick@deq.state.ut.us
6	Dan Hall	UDEQ – DWQ	801-538-9153	Dhall@deq.state.ut.us
7	Bill Moellmer	UDEQ – DWQ	801-538-6329	Wmoellme@deq.state.ut.us
8	Frank Roberts	UDEQ – DDW	801-536-0098	Droberts@deq.state.ut.us
9	Doug Taylor	UDEQ – DSHW	801-538-6857	Dtaylor@deq.state.ut.us
10	Chuck Williamson	UDNR – Water Rights	801-538-7392	Nrwrt.cwilliam@state.ut.us
11	Jared Manning	UDNR – Water Rights	801-538-7455	Nrwrt.jmanning@state.ut.us
12	Tom Munson	UDNR – DOGM	801-538-5321	Nrogm.tmunson@state.ut.us
13	Carl Kappe	UDNR – GSL	801 538-5273	
14	Bert Stolp	USGS	801-908-5061	Bjstolp@usgs.gov
16	Richard Bay	JVWCD	801-565-8903	RichardB@jvwcd.org
17	Mark Atencio	JVWCD	801-565-8903	MarkA@jvwcd.org
18	Richard Dansie	HRRR	801-254-4377	
19	Michelle Baguley	HRRR	801-254-4921	Mbaglady@hotmail.com
20	Roger Payne	West Jordan City	801-569-5761	RogerP@Wjordan.com
21	Steve Noble	South Jordan City	801-253-5230	Snobel@Sjordan.state.ut.us
22	Scott Endicott	Sierra Club	801-596-1325	Scott.endicott@cores.utah.edu
23	Mary Pat Buckman	SLCo. Health Dept.	801-313-6707	Mbuckman@eh.co.slc.ut.us
24	Ivan Weber	KUDC	801-743-4617	Kiweber@Kennecott.com
25	Ryan Evans	KUCC	801-569-6961	Krevans@Kennecott.com
26	Brian Vinton	KUCC-NAMS	801-569-7887	Kbvinton@Kennecott.com
27	Paula Doughty	KUDC	801-569-7120	Doughtyp@Kennecott.com
28	Jon Cherry	KUCC	801-252-3126	Cherryj@Kennecott.com
29	Mark Logsdon	KUCC-Geochimica	805-640-8697	Mark.Logsdon@worldnet.att.net
30	Helmar Bayer	KUCC – HBC International	801-569-7301	Khbayer@Kennecott.com

(REVISED July 16, 2001)



LEGEND	FIGURE 2-1	KUCC SOUTH FACILITIES RD
- - - - - - communication	Prepared by: JCC	
———— authority	Date: 8/3/01	PROJECT ORGANIZATION

3.0 TECHNICAL SCOPE OF WORK

3.1 Design

3.1.1 Purpose, Scope and Objectives of the Design

The purpose of the Remedial Design (RD) is to develop and document the technical requirements of the Remedial Action that will be executed by KUCC to resolve the CERCLA issues associated with contamination of groundwater from mining activities associated with the South Facilities of the Bingham Canyon mining complex. The general nature of conditions that need to be managed is presented in Section 1.4. Section 1.5, EPA's statement of the remedy, identifies the need for containment and extraction of contaminated groundwater, subsequent treatment of contaminated waters, and disposal of the water-treatment concentrates in a manner that will be protective of human health and the environment.

The scope of the RD includes engineering plans for three "functional units" of the conceptual plan:

- Groundwater containment and extraction system;
- Water treatment (NF and RO) and hydraulic delivery system for treated water and concentrate
- Treatment of acid-plume (NF) and Zone A (RO) concentrates and meteoric-leach water in KUCC tailings circuit.

As part of the RD process, KUCC will develop and document monitoring plans that include both (a) performance monitoring plans and (b) functional monitoring that will be used by KUCC to help operate the systems optimally.

The RD will address processes and designs that will be used by KUCC to meet the terms of the ROD both during operational stages and after the end of mining. It is expected that the level of detail for the operational phase will be greater than for the end-of-mining phase, as we expect that much will be learned during the period of expected operation that cannot be anticipated in detail at this time.

It is expected that the product of the RD process will be plans and specifications for a performance-based Remedial Action that would be detailed and executed by KUCC or the selected contractor(s). Whereas it might seem that the membrane-technology processes selected by KUCC for water treatment are better suited to a definitive design package, the performance requirements already have been resolved through the technology development and testing program that has been carried out by KUCC since 1995. Further elaboration of the technology throughout the remainder of the design period and then during operations will be directed by KUCC under supervision by Mr. Bayer (Section 2 above), and this will be guided by performance. The remainder of the integrated remedial program – part icularly the groundwater extraction and the geochemical treatment in the KUCC process circuit – will be designed on a performance-basis approach.

Objectives of the RD include:

- Identify data needs that must be resolved to develop the design criteria for each functional unit
- Develop and execute supplemental testing, sampling and analytical programs to address the data needs; these may include field and treatability studies
- Identify design criteria for each "functional unit" of the conceptual design; it is expected that the design will be primarily performance-based.
- Document the performance-based designs in detailed plans and specifications.

3.1.2 Design Criteria and Data Needs

This section will be organized around the three "functional units" identified above. The data needs are derived from the preliminary Failure Modes and Effects Analysis (FMEA) documented in Table 1-1 of Section 1.6 above.

3.1.2.1 Groundwater Containment and Extraction System

The selected remedy begins with a groundwater containment and extraction system that will (a) control further migration of mining-affected water, (b) remove mass of contaminants from the groundwater system, and (c) deliver the contaminated water to a water-treatment system, either the NF unit for acidic plume waters or one of the RO units for high-sulfate, non-acidic, groundwater from Zone A. The extraction system will be designed to remove contaminants from the most contaminated portions of the plume in Zone A as quickly as possible, by aggressively removing water through a series of extraction wells located in the core of the plume.

The RD will document final design criteria for groundwater extraction from Zone A, including the acidic plume water, and delivery of those waters from the wellheads to the water treatment system for the South Facilities. The criteria will address locations, well and pipeline designs, and design-basis extraction rates for specific wells. The design-basis extraction program is based on groundwater modeling conducted by KUCC, including on-going updates of such modeling in 2000 and 2001. The current, conceptual extraction plan for Zone A is summarized in Table 3-1 and Figure 3-1.

Table 3-1 Extraction Rates for the Proposed Remedial Strategy.

Well *(For ID/location, see attached figures)*	Model Layer*	Pumping Rate (gpm)	Pumping Rate (as: ac-ft/yr)	Years
Acid Well (ECG1146)	4	1250	*(2000)*	0-5
New Acid Well #1	4	750	*(1200)*	6-15
New Acid Well #2	4	1250	*(2000)*	0-30
New Acid Well #3	4	Varied †	*(Varied †)*	6-50
New Acid Well #4	4 (50%), 5 (50%)	Varied ††	*(Varied ††)*	16-50
K109	4	500	*(800)*	0-50
K109	5	750	*(1200)*	0-50
K109	6	250	*(400)*	0-50
B2G1193	4	333	*(533)*	0-50
B2G1193	5	667	*(1067)*	0-50

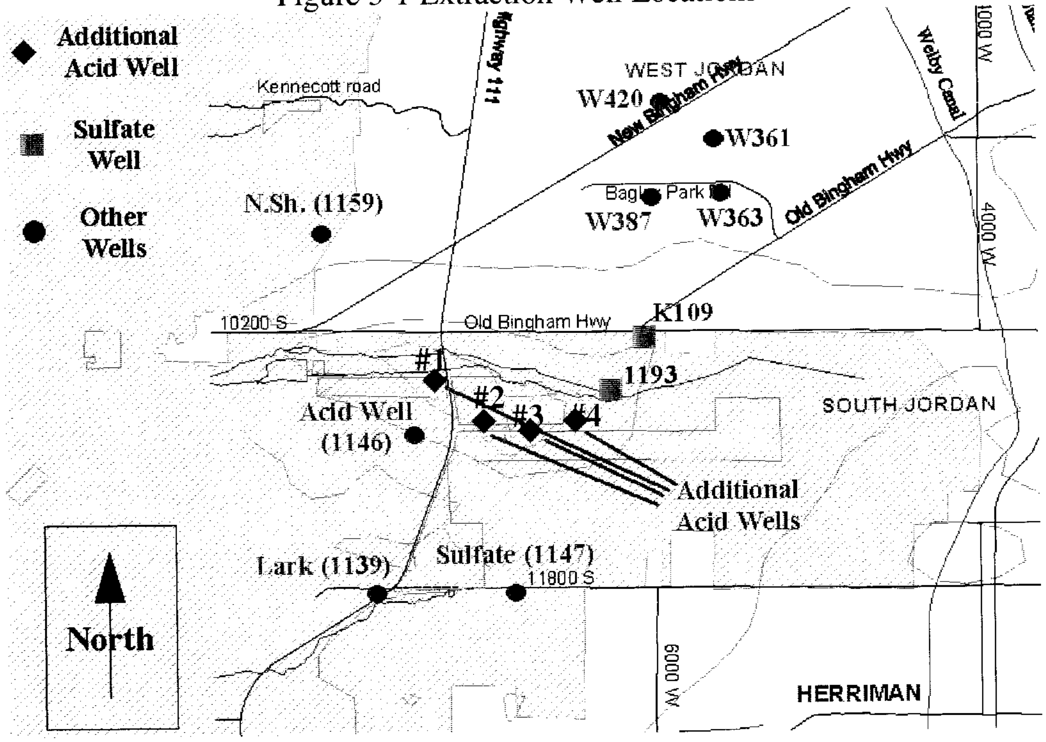
* **Layer 3 is approximately 0 – 150 feet below the groundwater table**
Layer 4 is approximately 150 - 300 feet below the groundwater table
Layer 5 is approximately 300 – 450 feet below the groundwater table
Layer 6 is approximately 450 – 650 feet below the groundwater table

† **Varied Pumping: Years 6-30, 500 gpm (*800 afy*); Years 31-50, 1250 gpm (*2000 afy*)**

†† **Varied Pumping: Years 16-30, 750 gpm (*1200 afy*); Years 31-50, 1250 gpm (*2000 afy*)**

Placement of these wells is shown below in Figure 3-1.

Figure 3-1 Extraction Well Locations



In addition to groundwater extraction wells, the RD will document design criteria for conveyance pipelines that deliver extracted groundwater from the wells to the water-treatment system.

The RD will evaluate the groundwater extraction systems in the context of the full groundwater hydrology of the site, including the Eastside Collection System and the mine de-watering program. However, the design will include criteria for only those extraction and collection systems that are part of the CERCLA remedy. In addition to engineering designs for the extraction and collection systems, the RD will establish performance criteria and a monitoring system to demonstrate that the systems are working as designed.

The initial failure modes and effects analysis has identified only three issues with significant consequences for the groundwater extraction and delivery system:

a) Greater than currently planned volumes (including additional volumes collected from larger areas) of groundwater need extraction to control the plume(s) or to provide sufficient clean water to meet NRD commitments
b) Pumping rates over-draft the aquifer and extraction must be decreased
c) A pipeline failure between wellhead(s) and water treatment facilities spills contaminated groundwater.

To address optimization of the extraction system, additional data and analyses may be needed to optimize: (a) well placement and the pumping-system configurations; (b) local and total extraction rates; and (c) material properties of the wells, based on the chemical reactivity of water in the proposed pumping locations. There also may be a need to further refine the hydraulic analysis to consider the cost-effectiveness of combining hydraulic injection of clean water with groundwater removal at nearby wells in terms of optimizing the containment and treatment goals of the project.

Pipeline failures are addressed through the mine's general spill prevention, control and containment plans (SPCC), which will be updated as necessary to address the specific pipelines of this project. No additional studies are expected.

3.1.2.2 Water Treatment (NF and RO) and Hydraulic Delivery System for Treated Water and Concentrate

KUCC already has developed preliminary designs for water-treatment processes and has demonstrated the technical feasibility and cost-effectiveness of the unit processes at both pilot- and initial (ca. 30% of final production rate) operational scales. The water treatment processes include nanofiltration (NF) for waters from the acidic plume and reverse osmosis (RO) for other Zone A waters that are high in sulfate but are not highly acidic. A separate RO unit that is part of the Zone A plant may be used to treat the permeate (i.e., clean water) from the NF unit prior to discharge. Performance criteria for the unit processes have been defined. In addition, KUCC already has a storage and pipeline system for delivery of poor-quality water from the South Facilities to the KUCC tailings circuit.

With respect to normal operations, the remaining Design tasks for this functional unit are:

(a) Optimize the water-treatment system across the remaining scale-up levels;
(b) Document the final designs for the storage and pipeline facilities for the water-treatment system;
(c) Document plans and specifications for the pipeline system(s) that will deliver clean water, and
(d) Document a monitoring program to demonstrate that the system and its components are operating in control with respect to its performance criteria.

The only failure mode with significant consequences for the treatment system that has been identified to date is the possibility that larger volumes of groundwater requiring treatment would be extracted than is currently planned. The Final Design will include a description of plans and schedules to expand the capacity of the treatment systems, should unexpected, additional capacity be required in the future.

3.1.2.3 Management of Water Treatment Concentrates (NF and RO) in KUCC Tailings Circuit

While the mine is operating, concentrates from the acid-plume (NF) and Zone A RO treatment systems will be conveyed to the Magna Tailings Impoundment (North Impoundment) in two existing pipelines. After mine closure, effluents from the treatment systems will be conveyed to the Great Salt Lake via a concentrate discharge line, provided the water chemistry at that time meets discharge limits. If one or both of the concentrates is not suitable for direct discharge, then additional treatment (e.g., lime addition) or alternative disposal (e.g., evaporation) will be needed. If concentrate from treatment of Zone B wells cannot be discharged to the Jordan River, these concentrates may also be delivered to the KUCC system.

The RD will document the plans and specifications for pipelines from the treatment facilities to the disposal points, including plans to control and remove (as necessary) scale in the discharge lines. No additional technical studies are anticipated for this activity. Spill containment and contingency plans will be documented under modifications to existing KUCC plans.

An innovative aspect of the disposal system is the use of the KUCC tailings circuit to neutralize acidity and remove metals and metalloids from water-treatment concentrates and meteoric leach waters. Preliminary, bench-scale testing and ongoing, water-quality monitoring programs and mass-balance modeling (addressing inclusion of groundwater plume and leach-circuit water in the tailings slurry) have demonstrated that existing systems can manage flows at 67% of the expected, full-scale rates. KUCC already has plans to increase the capacity to accommodate full-scale flows when they are delivered. Were the tailing to have neutralization potentials inadequate to neutralize the acidity, the concentrator and tailings-disposal system have the capability of adding additional lime to the system to control pH, if necessary, to levels that would meet treatment objectives and maintain UPDES effluent discharge limits. Final performance standards for this portion of the remedy need to be developed and documented as part of the RD.

Preliminary analysis has identified three potential failure modes with significant consequences for the remedial action regarding treatment of NF and RO concentrates in the tailings circuit:

a) Mechanical failures of the slurry pipeline system
b) Treatment of the full-scale system in the tailings circuit does not reduce adequately the acidity and metals concentrations in the slurry under short- or long-term conditions
c) Water quality of residual effluents is not adequate for direct discharge to Great Salt Lake when mining ceases.

KUCC's SPCC procedures will be updated, as necessary, as part of the Final Design to address the slurry pipeline during Remedial Action. The potential for scale to develop in the pipeline at volumes sufficient to affect the performance of the treatment and delivery system has been recognized by KUCC, and procedures to control or remove scale have been developed. The monitoring and maintenance programs addressing scale will be addressed in the Final Design.

To date, laboratory test work, monitoring and modeling have not addressed the specific mechanisms of metals removal in the tailings circuit, impacts (if any) of short-term excursions in slurry and decant chemistry on metals in the tailings system, the long-term geochemical stability of the metals from this waste stream in the tailings environment, or the full-scale addition of the groundwater treatment streams to the tailings circuit. Therefore, additional studies (Section 3.1.3.3 and Attachment 1, below) will be undertaken during the RD process to answer these data needs and to determine the detailed plans and specifications needed to achieve the performance standards for this functional unit of the remedy. The additional studies also will address (a) treatment alternatives for the period in which mining is completed and tailings no longer are available, and (b) monitoring programs to demonstrate that the operational system will meet the performance standards.

There are two conceptual routes by which water-quality of the water-treatment effluents may not be satisfactory for discharge to GSL:

a) Mining continues as anticipated in the RI/FS, however the extraction system does not achieve the requisite restoration of groundwater quality by the time mining ceases.

b) There is a premature closure of mining operations or a curtailment of mining that reduces the tailings production to levels that do not provide adequate treatment.
c) The existing system fails to treat effluents to acceptable levels.

The former case can be addressed, in part, by careful monitoring of water quantity in the aquifer during the extraction process. When the monitoring data are assessed through ongoing groundwater flow and transport modeling, KUCC could modify extraction rates to accelerate removal and treatment. A comprehensive performance monitoring program will be part of the Final Design.

If operational adjustments to the design-basis system are inadequate, then the problem becomes equivalent to the second variant of this failure mode. As discussed conceptually in the Feasibility Study and ROD, discharge to GSL will occur if and only if the effluent quality meets discharge standards that will be developed under a UPDES permit for such disposal and any other state or federal permits that may be required. Therefore, as part of the RD, KUCC will review, update and expand, as necessary, the alternative disposal options that were identified in the FS. These may include, but not necessarily be limited to, evaporative disposal in engineered cells in the final tailings surface or on the waste-rock piles; chemical (e.g., lime) treatment with subsequent water management and solids handling; and advanced water-treatment systems to remove acidity.

These contingencies are considered unlikely in the short term, and they are very unlikely to be required rapidly or without warning. The underlying situations would develop over a substantial period of time and could be identified through the base-case monitoring programs and KUCC's mine-planning process. This would allow KUCC ample time to consult with EPA and UDEQ to take proactive measures. Therefore, the additional activities addressing these matters in the RD are expected to develop information only to the level of a Preliminary Design.

3.1.3 Design Tasks/Activities

The RD tasks and activities are identified by functional unit, as discussed above. Tasks or activities that are annotated with the symbol (**) are ones for which a report of investigations is anticipated. The results of the other tasks and activities will be incorporated into the Preliminary and/or Final Design Reports.

3.1.3.1 Groundwater Containment and Extraction System

Tasks and activities related to the groundwater containment and extraction system include:

a) Complete the necessary Preliminary Evaluation Reports (PERs) and Drinking Water Source Protection (DWSP) plans for each existing and new well (**)

b) Document performance criteria for extraction wells (e.g., volume of water extracted; water-level response; water-quality changes), and prepare annual performance charts documenting well performance and KUCC response to issues. (**)
c) Document baseline water-level and sulfate condition for Zone A and adjacent areas at initiation of RD process. (**)
d) Update and recalibrate the groundwater flow and transport models. The additional modeling will include formal sensitivity analysis of system hydraulics, and the model documentation will address issues associated with (a) variable density in the groundwater plumes and (b) variations in regional and local recharge. (**)
e) Optimize well-field geometry and pumping rates (**); it is expected that the optimization studies would address alternative pumping strategies if physical or chemical responses in the aquifer are unsatisfactory.
f) Evaluate clean-water injection to supplement containment (**). If injection is recommended, separate activities will be initiated promptly to address permitting and injection-specific monitoring.
g) Document monitoring programs [including methods and procedures (e.g., specific analytes and sampling frequencies in specific wells) for monitoring and for quality control] that will be used to operate the flow system and to demonstrate compliance with the performance standards for the containment and extraction system. The monitoring program will be designed to detect as early as possible when field conditions deviate from predicted conditions. The program will address both temporal and spatial aspects of groundwater monitoring. (**)
h) Document quantity and quality of all groundwater flows that will be routed to the treatment system. (**)
i) Develop contingency plans for mitigation of water level declines, if these exceed performance criteria for the Principal Aquifer during the Remedial Action. (**)
j) Document schedule for well and pipeline construction.
k) Document construction, development and procedures for wells and pumps.
l) Document pipeline plans and specifications.
m) Document operations and maintenance plans for wells, pumps, pipelines and monitoring systems.
n) Update existing spill containment and contingency plans for inclusion in the Final Design Report.

3.1.3.2 Water-Treatment and Hydraulic-Delivery System for Treated Water and Concentrate from both NF and RO Units

Tasks and activities related to the water-treatment and hydraulic-delivery systems include:
a) Document as-built plans for treatment system, including non-proprietary data and generalized flow sheets for processes.
b) Document design-basis treatment capacity requirements as a function of time. (**)
c) Optimize unit processes as flows increase and empirical water quality develops.
d) Document schedule to increase capacity of modular treatment streams.

e) Document pipeline plans and specifications.
f) Document monitoring program to demonstrate that permeate for delivery to drinking-water suppliers meets all performance standards. (**)
g) Document monitoring plan for treatment of concentrate. (**)
h) Document operations and maintenance plans for treatment and monitoring systems.
i) Update existing spill containment and contingency plans for inclusion in the Final Design Report.
j) Obtain construction permit for Zone A RO treatment plant.

3.1.3.3 Management of Meteoric Leach Water and Water-Treatment Concentrates in KUCC Tailings Circuit

Tasks and activities related to management of meteoric leach water and water-treatment concentrates in the KUCC Tailings Circuit include:
a) Document the existing mass-balance model for the tailings circuit and evaluate the need for and feasibility of adding additional reactive chemistry to the model (**).
b) Evaluate changes in slurry chemistry through tailings circuit as a function of (i) mine planning, (ii) ore feed and tailings management, and (iii) Zone A concentrate inputs. (**)
c) Evaluate specific removal mechanisms that occur in different parts of the tailings circuit. (**)
d) Evaluate the time-variant stability of attenuated metals and metalloids in the tailings impoundment. (**)
e) Evaluate water quality trends over time to determine whether and when it would be appropriate to discharge to Great Salt Lake, based on discharge criteria that will be determined by the State of Utah.

A more detailed scope of work for this component is provided as Attachment A.

In addition, the geochemical work plan will evaluate alternative treatments (e.g., lime treatment and evaporation) to address the period when tailings are not available for reaction. These studies also will include reports of investigations.

3.1.4 Design Deliverables

KUCC anticipates four, principal deliverables as part of the Remedial Design Phase:

1. Remedial Design Work Plan
2. Preliminary Design Report
3. Reports of investigations for the additional field and treatability studies identified above
4. Final Design Report.

In addition, during both the remedial design phase and during operations, KUCC will prepare annual monitoring reports, based on quarterly monitoring data that also will be reported to the TRC and other peer reviewers. The nature of reporting on the monitoring program will be documented in the Remedial Design Monitoring Plan that is part of the documentation for the Final Design Report.

As discussed in Section 2.4 above, KUCC will utilize the Technical Review Committee to provide peer review of the RD process and products, including monitoring data. KUCC anticipates regular, quarterly meetings with EPA's Technical Review Committee, as well as other, topical meetings with the TRC that may be suggested by either KUCC or the TRC. TRC meetings will be documented through written minutes. There will be monthly progress reviews with EPA and UDEQ (Section 2.3, above), and topical or programmatic reviews could be initiated by EPA's RPM or UDEQ at any time.

3.2 Failure Modes and Effects Analysis

The Failure Modes and Effects Analysis will be reviewed and updated, as necessary, as part of both the Preliminary Design and the Final Design.

3.3 Health and Safety Plans

Typical CERCLA remediation sites have their own Site Specific Health and Safety Plan (HSP). Unlike most typical CERCLA remediation sites, KUCC is an active industrial mining site that is administered under the Mine Safety and Health Administration (MSHA) under regulations encoded in 30 CFR 56 (Safety and Health Standards Surface Metal and Nonmetal Mines). This agency certifies KUCC's safety program and conducts random safety audits throughout the year. All KUCC employees and contractors working on site are required to complete the mandatory MSHA safety training before they are allowed to work on site. Strict compliance with KUCC's safety program is mandatory as detailed in KUCC's safety standards manual. In addition to receiving the MSHA training, contractors also participate in a pre-job conference to review in detail the specifics of the upcoming work to be performed, all applicable safety requirements and any environmental requirements that they are expected to meet.

KUCC's existing, MSHA certified, safety program has been effectively used during the source removal/source control and RIFS projects in lieu of a project specific HSP. This same approach will be continued during the remedial design.

3.4 Data and Records Management Plan

As part of the remedial design, a Data and Records Management Plan (DRMP) will be prepared to document the data and records management process. The DRMP will present the strategy for documenting, managing and storing information and reports generated as part of the remedial design and remedial action phase. The DRMP will address handling of electronic files as well as hard copies. The record keeping and retention procedures will be consistent with KUCC's agreements with agencies. The

DMRP also will discuss the procedures for transferring data (both hard copies and electronic) to EPA and UDEQ.

3.5 Monitoring Plan for Remedial Action

Typically, a Sampling and Analysis Plan (SAP) is prepared for all project related sampling. The SAP consists of three parts; 1) Field Sampling Plan (FSP), 2) Quality Assurance Project Plan and 3) Data Management Plan. KUCC is in a unique situation in that it has an existing and ongoing Ground Water Characterization and Monitoring Program (GCMP). The GCMP documents all the Standard Operating Procedures (SOPs), Quality Assurance Project Plan (QAPP), data management and sampling locations and frequencies for all surface water and groundwater samples collected at KUCC as part of State surface water and groundwater discharge permits. The GCMP is a State approved plan and has been used as the accepted QAPP and Data Management Plan during the RIFS projects.

For the remedial design and remedial action, the GCMP will continue to be used as the QAPP. The data management for the remedial design and remedial action will be implemented as described in section 3.5. A new Monitoring Plan will be developed specifically to document and evaluate; 1) baseline water levels and the effects of long term pumping, 2) changes in water quality as a function of pumping and 3) the effectiveness of containment and extraction strategies described in the ROD. The Monitoring Plan will describe the sampling objectives, sampling program and schedule, sample handling and analysis, data quality objectives and analytical laboratories to be used. The Monitoring Plan also will describe the means of reporting the results of the sampling activities.

3.6 Preliminary Design for Long-Term Water Management

The basic plan for CERCLA disposal of water-treatment concentrates and meteoric leach flows requires the alkalinity and attenuative capacity of the tailing. The FS assumed that tailing would be available until ca. 2030, by which time the acidic groundwater plume should be largely, if not entirely, treated. However, it is possible that, whenever the, mine closes, groundwater in the Zone A and B plumes still will require treatment and management. There also are scenarios for temporary cessation of mining for which KUCC requires contingency plans.

EPA and UDEQ have requested discussion in this work plan of RD studies leading to a plan for post-closure management of water. KUCC intends to prepare a preliminary post-closure plan at the level of a preliminary design as part of the Final Design Report, due in December 2002. The following material presents KUCC's proposed approach to developing the preliminary design through activities to be carried out by KUCC and consultants during the Remedial Design phase. This level of discussion will be updated in the Preliminary Resign Report in October 2001.

3.7 Technical Approach

1. Assume that preliminary design needs to address only the CERCLA and NRD requirements. It is understood that such plans would have to be integrated with plans for closure of other KUCC facilities, however the CERCLA/NRD plume-management and remediation program is not identical to KUCC's overall closure program. Therefore, this plan will explicitly address only issues related to management of water-treatment concentrates and mine-water flows that currently report to the process circuit.
2. Assume, based on test data to date, that RO concentrates from the Zone A and Zone B sulfate streams would be suitable for direct discharge to Great Salt Lake. The contingency behind this assumption is that KUCC has adequate waters for mixing (e.g., dewatering of Garfield area; Riter Canal) should the RO concentrates have slightly higher than acceptable levels of some constituents.
3. Therefore, the long-term treatment issue is limited to acidic flows, i.e., concentrates from the NF treatment of acid-plume water and management of meteoric leach flows and other waters that report to the Eastside Collection system and are routinely discharged trough the Copperton Concentrator system.
4. Short-term contingencies (less than about 6 months) would be addressed by storing water in available reservoirs on the South Facilities, using short-term treatment (e.g., evaporation) to the extent practicable. Any stored water would have to be treated after production resumes. Therefore, as part of internal KUCC planning, the team will evaluate costs and benefits of using idle facilities for treatment (e.g., using NP5/6 for lime treatment with sludge disposal through the tailing line to the North Impoundment).
5. The base-case for post-closure management of acidic flows would be the FS alternative of lime treatment, per the Montgomery Watson study, with sludge disposal in a new, dedicated impoundment. Based on existing test work, we will assume that the sludges pass TCLP.
6. During the RD Phase, the KUCC team (lead by Helmar Bayer) will develop a series of technical studies – to be documented as KUCC reports under Item 47 of the RD project schedule (Work Plan Figure 7-1) -, including:

- Evaporation
- Use of RO concentrates as sealant for waste rock and/or pit walls and floors
- Pipeline scaling during transmission of RO concentrates
- Selective extraction/precipitation of solutes from acidic concentrates
- Use of KUCC pits for sludge disposal
- Leach testing of lime-treatment sludges

At this time, we anticipate that the preliminary design for post-closure management will be the base case, lime-treatment system. The plan also may recommend additional evaluation and engineering of other management options, based on the results to date of the treatment studies such as selective precipitation to remove metals and mineral acidity.

4.0 PERMIT REQUIREMENTS PLAN / INSTITUTIONAL CONTROL PLANS

4.1 Permit Requirements Plan

The remedial program is being performed under CERCLA and pursuant to a three-party agreement between the State of Utah, EPA and KUCC (dated September 27, 1995). The following draft Permits Requirements Plan was prepared to identify the applicable or relevant and appropriate (ARARs) pertaining to permits for the work to be completed as part of implementing the remedy at the site. The plan also presents how the substantive requirements of these permits will be met, at least to the extent that it is known at this early stage of the remedial design process. As the design progress, the specific permit requirement will be identified and addressed in more detail. A final Permitting Plan will then be generated as part of the Preliminary Design Plan.

Typically when remedial activities are being conducted pursuant to a Consent Decree or AOC which state that the actions are consistent with the National Contingency Plan and CERCLA, permits are not required for any onsite work. Because of the unique nature of this project and pursuant to the three-party agreement, permits will be obtained where necessary and appropriate (i.e., part of the remedial design will create a clean drinking water source for municipal consumption). Permits that are typically required for the activities associated with the selected remedy are outlined below.

4.1.1 Effluent Discharge Permit

As outline in the ROD, remedial activities to be conducted at the site will generate the following waters which will be discharged to KUCC's tailings circuit: 1) NF Plant concentrate and 2) RO Plant concentrate. Excess water from the tailings circuit is discharged to the GSL through a UPDES permitted outfall (012). The conditions of discharging the concentrate streams to the tailings circuit are that the tailings slurry is not characteristically hazardous when it leaves the pipeline and that the existing UPDES permit conditions are met at the outfall. The existing permit also indicates that if the quantity or quality of water in the process circuit is to significantly change, that a permit modification must be obtained. Although the NF concentrate stream is similar in quantity and quality to other waters permitted to be discharged to the tailings line, it has not been specifically identified as a constituent thereof. Similarly, the RO concentrate stream has not been specifically identified as a constituent of the tailings/process water circuit. Therefore, UPDES permit No. UTD0000051 must be modified to include these concentrate streams.

4.1.2 Drinking Water Source Permit

The selected remedial alternative calls for containing, extracting and treating contaminated groundwater and producing clean drinking water for consumption by local municipalities. This drinking water will be considered a new source and will comply with existing State rules for a drinking water system. Therefore, a Preliminary Evaluation Report, Source Protection Plan and drinking water permit will all be required for this part of the remedial design.

4.1.3 Groundwater Discharge Permit

The selected remedial technology utilizes membrane filtration to partition the contaminated groundwater into permeate (cleaner water) and concentrate (highly concentrated contaminated water). The NF and RO treatment facilities will be located above the contaminated aquifer, and spills will not have a significant detrimental affect to the contaminated aquifer. However, both concentrate streams will contain concentrations of contaminants higher than those found in the aquifer. Discussions with UDEQ will determine the applicability and need for a groundwater discharge permit.

4.1.4 Construction Permits

The treatment facilities to be constructed will be located on KUCC property and serviced by KUCC utilities (power, water, sewer, etc.). In many instances, construction permits are required for water treatment facilities regardless of location. A construction permit was previously obtained for the NF treatment facility, and it is anticipated that an additional construction permit will be required for the Zone A RO treatment plant.

4.1.5 Air Emissions Permit

Other than controlling fugitive dust per State rule (R307-215) during construction activities, no air emissions are anticipated that would require an air permit from the UDEQ Division of Air Quality. As the remedial design progresses, potential air emission sources will be evaluated and communicated to UDEQ to determine if a permit is required.

4.2 Institutional Controls Plan

The following draft Institutional Controls Plan has been prepared to outline the efforts needed to establish and implement the institutional controls included as part of the remedy for the site. The institutional controls that apply to this site include both access restrictions and point of use restrictions, as described below. To properly implement the use restrictions as described herein, KUCC will need the assistance of the State

Engineer, EPA, and UDEQ that oversee the future use of land and water within and adjacent to the project area.

4.2.1 Access Restrictions

Access restrictions are controls or measures that will be taken to prevent or limit access to the site. For much of the KUCC site, a fence currently surrounds the perimeter of KUCC property and is patrolled by security hired by KUCC. The design submittals will include requirements to ensure that the perimeter fencing is maintained, that no trespassing signs are posted and maintained and that security continues to patrol the area.

4.2.2 Use Restrictions

Use restrictions for the site will include specific deed notifications and restrictions, groundwater use restrictions, well installation restrictions and a moratorium on new water rights.

4.2.3 Land Use Restrictions

By restricting future use of the property in the deed, the future occupant/owner will be protected from potential hazards and contaminants. Restrictions on future use also will protect drinking water source areas through a drinking water source protection plan that is required as part of the drinking water permit. Further, land use restrictions also will be designed such that the perpetual water treatment activities are not negatively affected. Such restrictions could include a restriction on the depth that footings or utilities may be placed in certain areas of the site, restrictions on excavating within areas that have been capped and possibly permanent easements though certain sections of the site. The process of implementing the deed restrictions typically involves creating a restrictive covenant that the owner of the property signs and the City or County attaches to the deed.

4.2.4 Groundwater Use Restrictions

Restrictions on the use of water from existing wells, restrictions on the installation of new wells and a moratorium on new water rights within and adjacent to the project area should be established through the State Engineer and Department of Water Resources. KUCC has already petitioned the State Engineer to implement the moratorium on new water rights that will minimize the effects of aquifer draw down related to the containment and extraction remedial strategy approved in the ROD.

5.0 DESIGN QUALITY CONTROL

This is a unique remediation project and remedial design. The containment and extraction system were designed, installed and tested during the RI/FS process. The acid extraction well was installed and successfully tested at approximately 500 gpm in conjunction with modular units of the NF Plant. The design work and much of the construction are basically complete for this part of the project. The only items left to complete are to add additional modules to the system as treatment flows are ramped up to 2500 gpm.

The containment wells for the sulfate have been in operation for several decades supplying process water to the Copperton concentrator. After the design and construction of the RO Plant, these wells will continue to be pumped, but will be routed to the RO plant rather than the concentrator. Since this system will be producing drinking water, the design and construction of this are subject to the review and approval of the UDEQ Division of Drinking Water as part of the process of obtaining a drinking water permit. To avoid duplicative oversight, it is recommended that the Division of Drinking water provide the primary review for this system as part of the overall remedial design.

QA/QC procedures will be implemented throughout the design process to ensure that the final design is technically sound, cost-effective, biddable, constructible and that the design meets the remedial action goals for the site. The following mechanisms will be used to assure that the remedial design is completed in a high quality manner.

- Criteria Committee Meetings
- Design checks at each design phase
- Operability reviews
- Constructability reviews.

Each quality check mechanism is summarized below. There are also specific procedures for checking and reviewing drawings, specifications, calculations and construction cost estimates and schedules.

5.1 Criteria Committee Meetings

Criteria Committee Meetings (CCMs) are internal (KUCC) project review meetings with both the KUCC project management team and KUCC Engineering Services. The first CCM will be held following the completion of the Remedial Design Work Plan to set appropriate criteria and directions for the work. A second CCM will be held prior to completion of the Preliminary Design to provide continued input throughout the project. The idea is to obtain input from experienced individuals at critical junctures in the remedial design. The objective of the meetings is to critically review the direction, criteria, budget and schedule of a project.

5.2 Design Checks

Design Checks are crucial to the overall success of the remedial design process and will consist of the following:

5.2.1 Preliminary Design Check

The Preliminary Design Check will be performed by KUCC or an independent third party who will review the design criteria, the preliminary monitoring plan, permit requirements, institutional control plans and check and approve drawings. This check also will review specifications, cost estimates and schedule. Following the Preliminary Design Check, the Preliminary Design will be submitted to the TRC for review.

5.2.2 95 Percent Design Check

KUCC or an independent third party will perform the 95 Percent Design Check at the point of the Draft Final Design. This check will be accomplished by having a senior person within each discipline review the calculations, specifications and drawings for that aspect of the design. This check also will review detailed construction cost estimates and schedule. The reviewer(s) will verify that design changes are technically sound and do not compromise the integrity of the project or create a potential safety hazard. After the reviewer(s) verify that any changes have been incorporated into the drawings, specifications, design analysis and cost estimate, a final check and approval of drawings will be completed. This information will then be incorporated into the draft Final Remedial Design and will be submitted to the TRC for review.

5.3 Operability Review

Following the Preliminary Design, KUCC or an independent third party will complete an operability review. The review will determine if the facilities can be operated and maintained with a reasonable level of effort, and without creating a health and safety hazard for the operators. The review will be performed by an individual with experience in the startup and/or operation of similar facilities.

5.4 Constructability Review

Following the Preliminary Design, KUCC or an independent third party will conduct a constructability review. The review will focus on the ability to execute the work described, conflicts between the specifications and drawings and the ability to complete the project within the time frame allotted.

6.0 PROGRESS MEETINGS AND REPORTS

6.1 Quarterly Progress Meetings

During the remedial design phase (and continuing through the remedial action phase), quarterly status meetings will be held with EPA and UDEQ to discuss the progress of the work. Most of the meetings will be conducted by conference call. The first meeting will be held within 90 days after the work plan is submitted to the TRC. The following findings will be covered in each meeting:

- Activities performed
- Significant findings
- Problems and corrective measures taken
- Quality assurance/quality control activities and findings
- Coordination issues impacting the work
- Significant future activities.

Minutes from the meetings will be prepared and distributed to those participating in the meeting within four weeks of the meeting.

6.2 Progress Reports

A written progress report will be prepared and submitted by KUCC to EPA and UDEQ on or by the 15 day of each month to document the activities of the previous month. The report will address the following topics:

- Progress made in relation to master schedule
- Problems identified
- Problems resolved
- Deliverables submitted
- Schedule updates
- Activities planned for the next four weeks.

6.3 TRC Meetings

TRC meetings will be on an as-needed basis (likely semi-annually) to discuss the progress of the project or to discuss significant changes in scope to the project. At this time the next TRC meeting is scheduled for October 2001 to discuss the Preliminary Design and submit the design to the TRC for review.

7.0 SCHEDULE FOR REMEDIAL DESIGN ACTIVITIES

7.1 Summary of Deliverables

A list of various deliverables to be submitted during the remedial design phase is shown on Table 7-1. A reference is included to direct the reader to the respective section of this RDWP where the deliverable is discussed in detail.

Two bound copies of each deliverable will be submitted to EPA and UDEQ. One copy of various deliverables will be submitted to specific members of the TRC based upon area of oversight and expertise.

7.2 Schedule

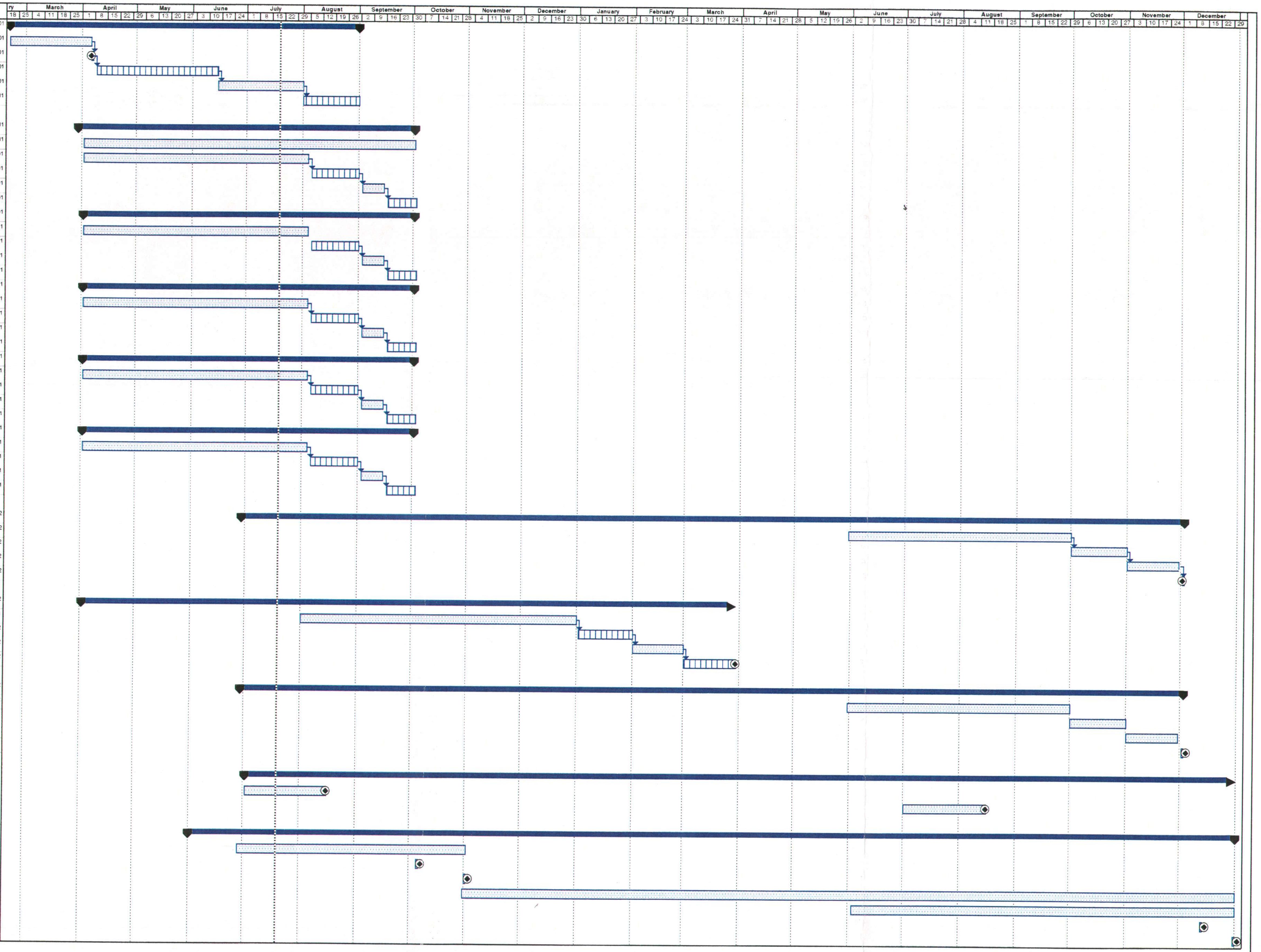
The schedule for completing the scope of work delineated in this RDWP is shown in Figure 7-1. To provide an overall picture of the time frame required to implement the remedy, a preliminary schedule for field activities assumes that favorable weather conditions will exist at the time of work. If this is not the case, the schedule will need to slip to accommodate weather conditions. The schedule will be updated periodically throughout the Remedial Design process, and subsequent versions of the project schedule will include actual dates, as they are determined.

The schedule shown in Figure 7-1 is aggressive and optimistic. A concerted effort by all parties will be necessary to meet the deadlines shown. This will entail frequent communication to discuss progress on deliverables and major issues, making sure that the first drafts of documents are a complete as possible, focused reviews by agencies and their consultants, and potentially reducing the number of design submittals. In addition to these efforts, it also will be necessary to prioritize the various deliverables and allow those designated as a lower priority to slip until after the critical path deliverables are complete. The color-coding of the tasks shown in Figure 7-1 indicates which items are considered critical path tasks, secondary priority and tertiary priority. As the project progresses, the priorities will be revisited and, if necessary, the schedule will be revised to assure that the critical path tasks are being given the highest priority.

Table 7-1 Summary Of Remedial Design Phase Deliverables

Document Name	Section Reference Number
Draft Remedial Design Work Plan	1.1
Final Remedial Design Work Plan	1.1
Draft Data and Records Management Plan	3.4
Final Data and Records Management Plan	3.4
Draft Work Plan for Tailings Geochem Study	3.1.2.3
Final Work Plan for Tailings Geochem Study	3.1.2.3
Draft Work Plan for Groundwater Study	3.1.2.1
Final Work Plan for Groundwater Study	3.1.2.1
Draft Groundwater Monitoring Plan	3.5
Final Groundwater Monitoring Plan	3.5
Draft Water Treatment Plan	3.1.2.2 and 3.1.2.3
Final Water Treatment Plan	3.1.2.2 and 3.1.2.3
Draft Report for Tailings Geochem Study	3.1.3.3
Final Report for Tailings Geochem Study	3.1.3.3
Draft Report for Groundwater Study	3.1.2.1
Final Report for Groundwater Study	3.1.2.1
Annual Groundwater Monitoring Report (2Q01)	3.5
Annual Groundwater Monitoring Report (2Q02)	3.5
Draft Report for Water Treatment	3.1.2.2 and 3.1.2.3
Final Report for Water Treatment	3.1.2.2 and 3.1.2.3
Preliminary Remedial Design	5.2.1
Final Remedial Design	5.2.2

ID	Task Name	Duration	Start	Finish
1	**Prepare Remedial Design Work Plan**	139 days	Tue 2/20/01	Fri 8/31/01
2	Prepare Draft RDWP	33 days	Tue 2/20/01	Thu 4/5/01
3	Submit Draft RDWP to TRC	1 day	Fri 4/6/01	Fri 4/6/01
4	Comments on Draft RDWP due Apr 30	49 days	Mon 4/9/01	Thu 6/14/01
5	Prepare and Submit Final RDWP	33 days	Fri 6/15/01	Tue 7/31/01
6	Agency Review/Approval of Final RDWP	23 days	Wed 8/1/01	Fri 8/31/01
7				
8	**Other Management/Work Plans**	132 days	Fri 3/30/01	Mon 10/1/01
9	**Prepare Data and Records Management Plan**	131 days	Mon 4/2/01	Mon 10/1/01
10	Prepare Draft Draft DRMP	90 days	Mon 4/2/01	Fri 8/3/01
11	Submit Draft DRMP for Agency Review	20 days	Mon 8/6/01	Fri 8/31/01
12	Prepare Final DRMP	10 days	Mon 9/3/01	Fri 9/14/01
13	Agency Review/Approval of Final DRMP	12 days	Mon 9/17/01	Tue 10/2/01
14	**Prepare Work Plan for Tailings Geochem Study**	131 days	Mon 4/2/01	Mon 10/1/01
15	Prepare Draft Work Plan for Tailings Geochem Study	90 days	Mon 4/2/01	Fri 8/3/01
16	Submit Draft Work Plan for Agency Review	20 days	Mon 8/6/01	Fri 8/31/01
17	Prepare Final Work Plan for Tailings Geochem Study	10 days	Mon 9/3/01	Fri 9/14/01
18	Agency Review/Approval of Final Work Plan for Tailings Geochem Study	12 days	Mon 9/17/01	Tue 10/2/01
19	**Prepare Work Plan for Groundwater Studies**	131 days	Mon 4/2/01	Mon 10/1/01
20	Prepare Draft Work Plan for Groundwater Studies	90 days	Mon 4/2/01	Fri 8/3/01
21	Submit Draft Work Plan for Agency Review	20 days	Mon 8/6/01	Fri 8/31/01
22	Prepare Final Work Plan for Groundwater Studies	10 days	Mon 9/3/01	Fri 9/14/01
23	Agency Review/Approval of Final Work Plan for Groundwater Studies	12 days	Mon 9/17/01	Tue 10/2/01
24	**Prepare Draft Groundwater Monitoring Plan**	131 days	Mon 4/2/01	Mon 10/1/01
25	Prepare Draft Groundwater Monitoring Plan	90 days	Mon 4/2/01	Fri 8/3/01
26	Submit Draft Groundwater Monitoring Plan for Agency Review	20 days	Mon 8/6/01	Fri 8/31/01
27	Prepare Final Groundwater Monitoring Plan	10 days	Mon 9/3/01	Fri 9/14/01
28	Agency Review/Approval of Final Groundwater Monitoring Plan	12 days	Mon 9/17/01	Tue 10/2/01
29	**Prepare Water Treatment Plan**	131 days	Mon 4/2/01	Mon 10/1/01
30	Prepare Draft Water Treatment Plan	90 days	Mon 4/2/01	Fri 8/3/01
31	Submit Draft Water Treatment Plan for Agency Review	20 days	Mon 8/6/01	Fri 8/31/01
32	Prepare Final Water Treatment Plan	10 days	Mon 9/3/01	Fri 9/14/01
33	Agency Review/Approval of Final Water Treatment Plan	12 days	Mon 9/17/01	Tue 10/2/01
34				
35	**Execute Tailings Geochem Study**	372 days	Fri 6/29/01	Mon 12/2/02
36	Prepare Draft Tailings Geochem Study Report	87 days	Fri 5/31/02	Mon 9/30/02
37	Submit Draft Tailings Geochem Study Report for Agency Review	23 days	Tue 10/1/02	Thu 10/31/02
38	Prepare Final Tailings Geochem Study Report	21 days	Fri 11/1/02	Sat 11/30/02
39	Submit Final Tailings Geochem Study Report to TRC	1 day	Mon 12/2/02	Mon 12/2/02
40				
41	**Execute Groundwater Studies**	260 days	Mon 4/2/01	Fri 3/29/02
42	Prepare Draft Groundwater Studies Report	109 days	Wed 8/1/01	Mon 12/31/01
43	Submit Draft Groundwater Studies Report for Agency Review	22 days	Wed 1/2/02	Thu 1/31/02
44	Prepare Final Groundwater Studies Report	20 days	Fri 2/1/02	Thu 2/28/02
45	Submit Final Groundwater Studies Report to TRC	21 days	Fri 3/1/02	Fri 3/29/02
46				
47	**Execute Water Treatment Studies**	372 days	Fri 6/29/01	Mon 12/2/02
48	Prepare Draft Water Treatment Study Report	87 days	Fri 5/31/02	Mon 9/30/02
49	Submit Draft Water Treatment Study Report for Agency Review	23 days	Tue 10/1/02	Thu 10/31/02
50	Prepare Final Water Treatment Study Report	21 days	Fri 11/1/02	Fri 11/29/02
51	Submit Final Water Treatment Study Report to TRC	1 day	Mon 12/2/02	Mon 12/2/02
52				
53	**Execute Groundwater Monitoring Plan**	392 days	Mon 7/2/01	Tue 12/31/02
54	Prepare and Submit Annual Reports following 2Q of Each Year	33 days	Mon 7/2/01	Wed 8/15/01
55	Prepare and Submit Annual Reports following 2Q of Each Year	34 days	Mon 7/1/02	Thu 8/15/02
56				
57	**Prepare Design Submittals**	413 days	Fri 6/1/01	Tue 12/31/02
58	Prepare Preliminary Design Submittal	91 days	Thu 6/28/01	Thu 11/1/01
59	Preliminary Design TRC Meeting	1 day	Fri 10/5/01	Fri 10/5/01
60	Submit Preliminary Design to TRC	1 day	Thu 11/1/01	Thu 11/1/01
61	Obtain Required Permits	305 days	Wed 10/31/01	Tue 12/31/02
62	Prepare Final Design Submittal	152 days	Mon 6/3/02	Tue 12/31/02
63	Final Design TRC Meeting	1 day	Fri 12/13/02	Fri 12/13/02
64	Submit Final Design to TRC	1 day	Tue 12/31/02	Tue 12/31/02



Project: SOUTH FACILITIES RDWP
Date: Thu 7/19/01

Task | Progress | Milestone | Summary | Rolled Up Task | Rolled Up Milestone | Rolled Up Progress | External Tasks | Project Summary | Split | Rolled Up Split

FIGURE 7-1

8.0 *REFERENCES*

Dames and Moore, 1988, Milestone Report I, data base synthesis: mathematical model of groundwater conditions, southwestern Salt Lake County, Utah: Contractor report to Kennecott Utah Copper, May, 64 p.

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Shepherd Miller, Inc. (SMI), 1996, Estimates of background concentrations of metals and non-metals in groundwater, southwestern Jordan Valley, Utah: Contractor report to Kennecott Utah Copper Corporation, December, 34 p. [Also Appendix B of KUC, 1998a]

Solomon, D.K. and Bowman, J.R., 1997, Stable and radioactive isotopes as tracers of groundwater and solute transport, SWJV, Utah: Contractor report to Kennecott Utah Copper Corporation, June, 37 p. [Also Appendix K of KUC, 1998a]

Attachment A
TECHNICAL MEMORANDUM

DATE: 30 March 2001

TO: **Jon Cherry (KUCC)**

FROM: Mark J. Logsdon (Geochimica)

SUBJECT: **GEOCHEMICAL IMPACTS OF TREATED WATERS FROM KUCC SOUTH FACILITIES ON THE NORTH TAILINGS IMPOUNDMENT, KENNECOTT UTAH COPPER CORPORATION, MAGNA, UTAH**

PURPOSE AND OBJECTIVES

The purpose of this memorandum is to propose a scope of work that will be performed. The work that is the subject of this proposal will be the geochemical and hydro-geochemical portions of the investigations needed to finalize technical aspects of the tailings-system disposal plans as part of the Remedial Design/Remedial Action (RD/RA) programs.

Specific objectives of the memorandum include:

- Identification of the general scope and technical approach to the proposed geochemical studies
- Identification of a general scope of work for the geochemical investigations.

GENERAL SCOPE

The general scope of the studies would be the geochemistry and hydrogeochemistry of the disposal system for the Zone A treatment fluids (i.e., concentrates from both the NF and the Zone A RO units) in the Copperton tailings line and the North Impoundment tailings facility. The work will address the: (1) specific geochemical and/or physical mechanisms of metals removal in the tailings circuit; (2) full-scale addition of the groundwater treatment streams to the tailings circuit for different scenarios of mine planning; and (3) short- and long-term geochemical stability of the metals from this waste stream in the tailings environment. Alternatives to tailings-system disposal (i.e., to address post-mining water management) will be addressed in a separate scope of work.

Evaluation of the tailings-disposal option will use work prepared primarily by others that describes the systems that (a) collect and transmit groundwater and meteoric leach water, (b) treat the collected waters through nanofiltration and reverse-osmosis treatment processes, and (c) manage the tailings production, disposal and reclaim aspects of the system.

It is expected that the products will include quantitative models of the disposal system that can be used by KUCC in long-term planning and in the development and implementation of monitoring programs.

TECHNICAL APPROACH

The technical approach to the study is expected to include the following elements:

1. **Description of the existing system and its planned enhancements.** This would include descriptions and critical evaluations of (a) the hydrogeochemical origin and existing conditions for groundwater and wastedump draindown; (b) the technical basis for estimating future flows and chemistries of ground-water and meteoric-leach solutions; (c) the tailings disposal system (including its miscellaneous inputs and outputs); (d) the design-basis wastewater treatment systems.

2. **Documentation of the hydraulic design and performance of the Copperton tailings line and any other piped systems and reservoirs that are needed to define the total flow system for the tailings disposal system**. The goal of this documentation will be to develop the conceptual model for the engineered disposal system as a chemical reactor (or as a system of coupled reactors). For example, it may be possible to describe the Copperton tailings line as a plug-reactor system with dispersion, chemical reaction (for some components), and feedback (via the decant return line system). Because both the water-treatment concentrates and the tailings slurry inputs are expected to vary in terms of volume and chemistry over time, the model will have to be developed in terms of transient conditions.

3. **Characterization of the general flow field(s) in the tailings system,** including the pipeline reactor and both the unsaturated and saturated portions of the North Impoundment.

4. **Description of the mineralogy of tailings and chemistry of tailings slurry.** The tailings mineralogy will include both the ex-concentrator tailings (probably a time-variant function of ores) and the secondary changes to tailings minerals that occur over time in the disposal system (e.g., pipeline scale and tailings mineralogy as a function of location and time in the impoundment, based on oxidation and other weathering reactions and KUCC changes to the system such as direct lime addition). The tailings-slurry chemistry will be extended to characterizing the pore-water chemistry of the tailings in the North Impoundment, as functions of both location

(x,y,z) and time as well as primary mineralogy.

5. ***Determination of the hydrogeochemical mechanisms responsible for changes in*** chemistry of (a) tailings slurry in the Copperton line; (b) decant solutions; (c) tailings pore-water in the impoundment; and (d) mineralogy and surface chemistry of tailings solids.

6. **Development of a quantitative model for the geochemical evolution of the tailings system** as a function of (a) inputs to the tailings line at the concentrator; (b) processes in the tailings line; (c) processes in the tailings impoundment; and (d) feedback to the tailings-line inputs from decant solutions and miscellaneous KUCC flows that report to the process ponds. The modeling, in conjunction with other studies, will address the long-term geochemical stability of metals and metalloids in the North Impoundment system.

GENERALIZED SCOPE OF WORK

Task 1. Compile existing databases and other information on groundwater hydrology and chemistry, tailings chemistry and mineralogy, mine planning, water treatment, and physical and chemical performance of the tailings system.

Task 2. Document and evaluate the existing groundwater flow and transport model(s) and the existing mass-balance model(s) for the tailings circuit.

Task 3. Develop (or elaborate) a conceptual model for the tailings-disposal system. The conceptual model should be carried through to an initial identification of the constitutive relationships that would be part of a mathematical model and the identification of methods to solve the mathematical relationships.

Task 4. Review the existing sampling and analysis plan for tailings and process-water system and modify as necessary to account for: (a) tailings mineralogy and geochemistry (including the mineralogy and geochemistry of scale formation in pipelines); (b) tailings slurry solutions and other liquid inputs to the tailings pipelines; (c) pore water in both saturated and vadose zones of the North Impoundment; (d) decant solutions; (e) tailings solids in the saturated and vadose zones; and (f) hydraulic parameters for the saturated and vadose zones.

Task 5. Analyze the tailings system hydraulics including (a) flow in pipelines (b) hydraulic conditions and processes in the saturated zone(s) (c) hydraulic conditions and processes in the vadose zone and (d) fluid recycling.

Task 6. Examine the mineralogy and geochemistry of tailings solids and pipeline scale.

Task 7. Analyze the chemistry of solutions.

Task 8. Evaluate geochemical mechanisms for fluid and solid changes.

Task 9. Develop and calibrate one or more quantitative models for the geochemical evolution of fluids and solids in the tailings system as a function of operational conditions and time (which will extend beyond the period of active mining).

Task 10. Prepare reports.

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Kennecott

August 3, 2001

Dr. Eva Hoffman
U.S. Environmental Protection Agency
999 18th Street, Suite 550
Denver, CO 80202-2466

Re: Responses to Comments on the KUCC South Facilities Draft Remedial Design Work Plan

Dear Eva:

Thank you for your review of the draft work plan. The purpose of this letter is to provide a response to your comments and questions and indicate how those issues will be addressed in the revised work plan. Each of your comments is listed below in italics followed by KUCC's response.

1. *I found the plan to be well organized and liked the failure analysis approach as a method to put the plan into context.*

   Several other reviewers also found the failure modes and effects analysis to be a useful tool in putting the plan into context. Based on other reviewers' comments, the failure modes and effects analysis will be modified slightly and will remain as an integral part of the work plan and remedial design process. As indicated in the draft work plan, updates to the FMEA will be part of both the Preliminary and Final Design submittals.

2. *The text seemed to be contradictory with regards to what was being done on the mine closure scenario and development of a plan to handle treatment residuals at that time. One section of the text indicates that there will be a feasibility study to evaluate different alternatives. Another section talks about development of a preliminary design, knowing that there would be sufficient time to develop the final design when the day gets closer. I suggest that a matrix with different plans depending on the nature of the concentrate at the time of closure. We want more than a feasibility study. The idea of doing less than a final design is appropriate, however.*

Our thinking at this time is to provide a preliminary post-closure design as part of the final remedial design in December 2002. The preliminary post-closure design will take into account the various water treatment options available depending on the date of closure, volume of acid extracted, potential treatment residues, etc. The text of the work plan will be revised to reflect this concept.

3. *It is my understanding that our cooperating federal agencies, the U. S. Army Corps of Engineers and the U. S. Geological Survey will be sending their comments to you under separate cover.*

Comments on the draft work plan were received from the U. S. Army Corps of Engineers on May 22, 2001 and the U. S. Geological Survey on June 12, 2001. Responses to their comments will be provided under separate cover.

Sincerely,

Jon Cherry

Jon Cherry, P.E.
Senior Project Engineer

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Kennecott

August 3, 2001

Mr. Douglas Bacon
Utah Department of Environmental Quality
Division of Environmental Response and Remediation
168 North 1950 West
Salt Lake City, UT 84116

RE: Kennecott Utah Copper, draft *South Facilities Groundwater Remedial Design Work Plan*, dated April 6, 2001 Version B.

Dear Mr. Bacon,

Thank you for your review of the draft work plan and providing the collective comments of the various UDEQ and DNR divisions. The purpose of this letter is to provide a response to those comments and questions and indicate how those issues will be addressed in the revised work plan. Each of your comments is listed below in italics followed by KUCC's response.

General Comments on the RD Workplan:

(1) It would be beneficial to describe the basic design elements before attempting to identify the potential failure modes. UDERR suggests that the current Section 3.0 be placed before the current Section 1.6 in the document, as it is important to know what the planned design components are in order to anticipate or calculate potential flaws and failures.

At the level of the RDWP, the identification of the remedy (Section 1.5) is all that really is needed to prepare the Preliminary FMEA. We will move (or perhaps copy) the second paragraph, identifying the three "functional units" of the conceptual plan, to the beginning of Section 1.6. Note that the FMEA is not an end in itself, but rather a tool that we have chosen to use to help develop the rationale for the information needs that remain to be addressed in the Remedial Design. The logic of KUCC's approach is that the FMEA drives the work plan, not the other way around.

(2) A matrix diagram showing inter-related impacts of one failure mode to another, or the impact of a possible mitigation of one failure mode creating another failure mode would be a

useful tool to include with Table 1-1. For example, if the design for extraction exceeds the state engineer's guidelines, reducing extraction rates may result in an inability to contain the plume. Well location is another Afailure mode≅ that should be included and it should be noted that improper well placement may have impact on many other identified or not identified AFailure Modes≅ (see specific comment #20).

As stated in Section 3.2 (p. 30) of the Draft Work Plan, both the Preliminary and Final design will include revisions to the FMEA, however, FMEA (unlike the event-tree/fault tree approaches used in probabilistic risk assessments) does not attempt to show the logical structure of contingent failures. The analysis in the Work Plan (identified as Preliminary) was prepared to guide the development of the work plans, not as a stand-alone tool for risk assessment. As a matter of formalism, it may be true that there is a related risk between (for example) extraction rates and plume containment, but so long as both are identified in the FMEA, then the failure modes and effects are accounted for and no additional information needed for design emerges from showing a logical connection.

(3) The Utah Division of Water Quality (DWQ) appreciates the planned regular updates and semi-annual meetings to keep participants informed of progress.

KUCC believes that the most efficient way to manage a project of this magnitude is to have frequent and open communication between the various stakeholders.

(4) DWQ would like it to be clear that the monitoring part of the RD activity is absolutely critical and has two distinct, but related parts. The first is performance monitoring of the KUCC property line for compliance with the spirit and intent of the ROD. A very detailed plan will be necessary which includes the location of wells to be monitored and may include new wells. The second is monitoring of the plume interior and acid withdrawal to determine the effectiveness of the pumping activities. Kennecott has used computer modeling to estimate pump rates and well locations. It is not clear that the modeling is sufficiently detailed to provide a high level of accuracy with regard to these parameters. Therefore, close monitoring of the withdrawal performance will be necessary to allow Kennecott to maximize the use of its tailings line and remove as much of the acid plume as quickly as possible. Again, a detailed plan for this part of the monitoring will be necessary that will include, among other things, well locations, continued modeling and possibly additional wells.

Monitoring plans, like contingency plans, are outcomes of the Remedial Design process. We do plan to have both (a) performance monitoring programs (and not only for the groundwater conditions in the field, but also for performance of the treatment plant and also for the effectiveness of the pipeline disposal system), and (b) functional monitoring that is used as a tool by KUCC to operate its systems.

(5) The conceptual extraction plan must be further evaluated during the RD/RA phase to demonstrate that pumping a limited number of wells can be effective in preventing offsite migration of contaminants in excess of allowable limits. The modeling done to date has approximations and uncertainties that most likely over estimate the effectiveness of the proposed pumping wells. Additional analysis and modeling must be completed during the RD/RA phase that better approximates the observed response to pumping.

Section 3.1.3.1 (p. 28 of the Draft Work Plan), identifies exactly the sorts of studies that this comment calls for: (d) update and recalibrate groundwater flow and transport models; (e) optimize well-field geometry and pumping rates; (g) document monitoring programs; (h) develop contingency plans for mitigation of water-level declines.

(6) In several places the plan discusses evaluating and/or using injection of clean water as a method of containment. DWQ does not object to acknowledging the possibility of using injection, however, the likelihood of such a project is very low. As has already been pointed out in previous CERCLA/NRDC proposal comments, injection water would have to meet DWQ=s strict injection control criteria. This assumes that sufficient evidence can be provided that injection will actually work as envisioned. Furthermore, using clean water for injection must overcome the additional hurdle of satisfactorily arguing that placing clean water in a contaminated aquifer is really the best use of such a limited resource.

We understand there are hurdles to overcome with respect to injection as a means of hydraulic containment of the plume. There are significant hurdles to overcome with many aspects of this remedial design, and we are trying to keep all feasible options open.

Rather than debate the philosophical opinions related to injection, KUCC plans to revisit the injection analysis work and make necessary adjustments based on the current remediation plan. Once a review of the technical feasibility of injection options is completed, a more meaningful discussion can occur in the context of the underground injection regulatory requirements.

Specific Comments on the RD Work Plan:

(1) Section 1.1 Purpose of Remedial Design Work Plan, 1st paragraph, page 1. Please be advised that the final remedial design to address ground water contamination needs to be in accordance with not only the U.S. Environmental Protection Agency's (EPA's) Record of Decision (ROD), but also the State of Utah Natural Resource Damage (NRD) proposal and corresponding project agreements. As noted in the cover letter, the technical information needs (determined during a review of the NRD proposal) have been deferred to the Remedial Design (RD) activities. This information should be specifically addressed in the Remedial Design Work Plan (RDWP).

Language will be added to this section which clearly indicates that the Remedial Design will be in accordance with not only the EPA's ROD, but also the State of Utah NRD proposal and corresponding project agreements.

The bulleted list, on page 1, should include a list of the uncompleted Feasibility Study documents, since they too were deferred to the RD activities.

A single bullet will be added to this section indicating Feasibility Studies that were deferred to the Remedial Design. Sub-bullets will list specific studies to be completed.

(2) Section 1.3.4 Hydrogeology - Groundwater Elevation Changes, 1st paragraph, page 6. The statement that ground water elevations have declined should be referenced.

Most of the discussion in section 1.3 is summarized from the RI report, as referenced in section 1.3.4 *Hydrogeology*, paragraph 1, "A brief discussion of [hydrogeologic] properties follows; refer to the RI report Appendix F for more details." and in section 1.3 *Summary of Site Characteristics*, paragraph 1. KUCC does not see the need to reference all the paragraphs to the RI. Where more-recent data was included in the Work Plan these sources should be documented. The 2nd paragraph in *Groundwater Elevation Changes* will be referenced to the Bingham Canyon Mine and Leach Collection System Groundwater Discharge Permit #UGW-350010 - 1999 Annual Report, (KUCC, 2000). Available water level data through 2000 was evaluated to write the 3rd paragraph. In this paragraph we will change "over the last five years" to "between 1995 and 2000" to make it clear that this in new information.

(3) Section 1.3.4 Hydrogeology - Groundwater Elevation Changes, page 6. As suggested by the State Engineer's office (see UDEQ comment letter on the NRD proposal dated May 11, 2001, Comment #10), requirements for compensation may be requested prior to the approval of the water right change applications. Please state or list the proposed corrective actions which may be taken by KUCC to compensate for the potential draw down the project will create. The elevation changes presented clearly show that the area of withdrawal will see significant draw downs. Please explain further the severity of the potential draw down the project will create.

Your comment represents a valid concern. However, it is important to understand that KUCC will not be diverting more water under the remedial plan than it historically diverted under its vested water rights. KUCC has filed a change application (a24720) and received State Engineer approval to move some of its vested rights to the existing and proposed wells contemplated in the remedial plan. Additionally, KUCC does not believe these issues should be addressed in the Remedial Design Work Plan. **Products** of the Remedial Design process (see sec 3.1.3.1 item i) can address draw down concerns as appropriate. Your comments are concerns are recognized and have been identified in the Remedial Design work plan as items that will be studied and addressed.

(4) Section 1.3.4 Hydrogeology - Groundwater Elevation Changes, 3rd paragraph, page 6. When discussing the declining water table in the area of the acid well, the text should mentioned the rate at which the acid well is extracting water from the aquifer. This may shed some light as to the cause for the reduction of the water table level in this area.

The pumping rate should be specified. The paragraph will be changed to: Water levels in the vicinity of the Large Bingham Reservoir and Lark have been stable (+/- 1 foot) from 1995 to 2000, during which time the Lark well has pumped an average of about 157 ac-ft per year. In the Acid Well (ECG1146) area, the water table is declining at about three feet per year. During 1996, the Acid Well pumped 71 ac-ft, in 1997 it pumped 223 ac-ft, in 1998 the total yield was 338 ac-ft, in 1999 it was 464 ac-ft, but in 2000 it was only 5 ac-ft. Higher withdrawals in the Acid Well area may be partially responsible for the water-level decline. It is also possible that the decline in the Acid Well area is an extension of the large sink in the West Jordan municipal wells and KUCC K60/K109 area.

(5) Section 1.3.4 Hydrogeology - Groundwater Elevation Changes, 4th paragraph, page 6. The paragraph implies that the decrease in water table levels is due to increased municipal well extractions. Please indicate whether the dramatic increase in development in the area (west side of valley) has decreased surface infiltration of meteoric water, while impacting aquifer recharge.

KUCC has not conducted any studies or researched this as part of the Work Plan. It is likely that this issue will need to be investigated when more groundwater modeling is undertaken for the Remedial Design.

(6) Section 1.3.4 Hydrogeology - Groundwater Velocity, 1st paragraph, page 6. The effective porosity of the area is generally reported to be 0.225 Awhich is typical of gravel.≅ Effective porosity of gravels are typically 0.200 and that of sand is typically 0.250, placing the effective porosity from the area as between sand and gravel. Please revise.

In the RI this statement is referenced to Freeze and Cherry, 1979, which gives typical porosity of gravel at 25-40% and sand at 25-50% on table 2.4, page 37. Applied Hydrogeology by C.W. Fetter (1988) gives typical porosity ranges for various sediments. In table 4.2, page 68 of Fetter, the porosity range given for "sand and gravel, mixed" is 20-35%. Effective porosity is less than total porosity because some of the pore spaces are not connected and therefore will not transmit water. We do not feel that this statement is in error, and to be consistent with the RI, from which this discussion is taken, therefore, the statement will not be changed.

(7) Section 1.3.4 Hydrogeology - Groundwater Velocity, 1st paragraph, page 6. As presented the calculated linear groundwater velocity is approximately 550 ft/yr, with a standard deviation of ∀ 525 ft/yr. Please explain how accurate this flow rate is, in light of the high standard deviation.

The comment appears to be confusing accuracy with precisions. Regardless, the RI report, from which this discussion is summarized, details a discussion of linear velocity and how it was calculated is given on pages 3-17 through 3-18. The large standard deviation results from including all velocity values from all the wells monitored during all the aquifer tests done for the RI. These wells are spread out over the SWJV in areas of with significantly differing hydraulic conductivity and gradient. The standard deviation would be much less if the velocities were grouped together into similar hydrogeologic zones, but the point here was to give an overall average for the a flow path from the Bingham Reservoir to the Jordan River, which crosses several hydrogeologic regions. Isotopic data give independent estimates of average linear velocity based on age dating. The isotopic study done for the RI yielded an independent apparent average velocity of 500-650 ft/yr (RI page 3-18). Text will be added to the paragraph that explains that the high standard deviation is a result of using a wide range of K values and that as an average linear velocity for the long flow path mentioned, and because isotopic evidence supports this value, that it is more accurate than the high standard deviation suggests.

(8) Section 1.3.4 Hydrogeology - Groundwater Velocity, 2nd paragraph, page 7. Please provide or reference the formulas used to calculate travel time and average linear groundwater velocity for the area between the Bingham Creek reservoir and well P190A.

This is a summary of the discussion on page 3-18 of the RI. Please refer to the RI for more complete details.

(9) Section 1.4 Nature and Extent of Contamination, 1st paragraph, page 7. In this paragraph sources of groundwater contamination are listed. Please indicate whether Butterfield Canyon is a source area and if it is, why it is not included in this action.

This is a discussion that lists "the principal <u>areas</u> of groundwater contamination", not the principal sources. These four general area classifications make it easier to discuss the locations of contamination and are not meant to be an exclusive list of the sources of the contamination.

(10) Section 1.4 Nature and Extent of Contamination - Bingham Creek Reservoir Area, 1st paragraph, page 7. For clarity and understanding please provide a table listing all the contaminants associated with the Zone A plume, the maximum concentrations of the contaminants and the average concentration of the contaminants of concern (COC=s). Please provide the State of Utah Ground Water Quality Standards for reference.

A table will be provided of a typical water quality sample from the Zone A plume (from the Acid Well, ECG1146) with the State of Utah Drinking Water Primary and Secondary MCLs.

(11) Section 1.4 Nature and Extent of Contamination - Bingham Creek Reservoir Area, 2nd paragraph, page 7. KUCC states in the 3rd sentence that Athe leading edge of this plume (as defined by sulfate greater than 20,000 mg/L) has migrated approximately 10,200 feet, since the

reservoirs were placed in operation in 1965.≅ UDERR would like to point out that the leading edge of the Zone A plume should be determined by using a concentration of 1500 mg/L sulfate (to maintain agreement with the EPA Record of Decision) rather than 20,000 mg/L sulfate. Please revise the sentence. The 20,000 mg/L sulfate contour line is more closely associated with the core of the plume rather than the edge of the plume. The 1500 mg/L sulfate contour was chosen as the compliance check for containment, because ground water above 1500 mg/L sulfate was to be contained on KUCC property per the EPA Record of Decision.

The sentence "The leading edge of this plume (as defined by sulfate greater than 20,000 mg/L) has migrated approximately 10,200 feet..." will be changed to "The leading edge of the highly-concentrated interior of the plume (as defined by sulfate greater than 20,000 mg/L) has migrated approximately 10,200 feet...". The sentence after the sentence in question describes the extent and location of the 1500 mg/L plume and will be left as is.

(12) Section 1.4 Nature and Extent of Contamination - Bingham Creek Reservoir Area, paragraphs 3 - 5, pages 7 - 8. Please explain the dynamics of contaminant distribution, both vertical and horizontal, in more depth. Please explain why sulfate tends to stay shallow and why the more acidic, heavy metal laden water tends to stay deep.

The acidic, high-TDS plume water has a density of roughly 4% greater than that of fresh water. The higher density, combined with mounding of the water table caused by leakage from the Bingham Creek Reservoir during plume formation were likely the cause of the downward migration of the heavy water. Another factor may be downward-dipping sedimentary layers from the alluvial fan sediments that make up a large portion of the aquifer in which the plume resides. We hope to gain a better understanding of the role of density in plume movement by the additional groundwater flow and transport modeling planned for the Remedial Design.

(13) Section 1.4 Nature and Extent of Contamination - (South Jordan) South Jordan Evaporation Ponds, 3rd paragraph, page 10. The discussion on pH is speculative. Either document that areas with pH values less than 6.5 are the result of natural processes in the aquifer or remove the speculative statement. It could also be true that acidic water that escaped the unlined evaporation ponds still exists in the area of the ponds.

The statement was documented in the paragraph in question as being from an independent consultant's report on background concentrations in the SWJV (Shepherd Miller, Inc.). The reader may chose to read this in more depth in the consultant's report, which was provided as Appendix B of the RI. The reason KUCC does not believe the pH <6.5 areas east of the Evaporation Ponds are remnant acidic water from the Ponds is that those areas do not coincide with the most-elevated sulfate and TDS areas, as is the case in the Bingham Creek Reservoir Plume. Four areas with >1500 mg/L sulfate east of the Evaporation Ponds were identified in the RI and only one of those areas has pH <6.5. Three of the five <6.5 pH values were in areas with

250 to 500 mg/L sulfate and one was completely isolated and near Rose Creek, far away from mining-impacted areas. There were two areas with pH >8.5, which adds to the argument that there is large natural variability in the groundwater east of the Evaporation Ponds.

(14) Section 1.4 Nature and Extent of Contamination - Lark Area, 3rd paragraph, page 10. The use of the word Adepressed≅in reference to pH levels is awkward. Please restate.

This sentence will be reworded "…. as do the local zones in which pH is less than 6.5"

(15) Section 1.5 Description of Selected Remedy, 4th bullet, page 12. The fourth bullet needs further explanation besides that given in the Record of Decision. The current cleanup proposal to the State NRD Trustee describes ground water withdrawal rates for the core of the plume significantly higher than those originally proposed in previous drafts of the NRD proposal. UDERR understands this to mean that KUCC intends to remove the core of the acid plume or Zone A more aggressively than originally suggested, to meet its goals of remediation. Please state in the bullet that it is KUCC=s intent to remediate the Zone A plume as quickly as possible, by aggressively removing water and contaminants from the most contaminated portions of the plume through a series of acid core extraction wells.

The fourth bullet on page twelve is quoted directly from the ROD and should not be changed. However, the text of the Remedial Design Work Plan will be modified in Section 3.1.2.1 (Groundwater Containment and Extraction System) to indicate that KUCC intends to remove contaminants from the most contaminated portions of the plume in Zone A as quickly as possible, by aggressively removing water through a series of acid extractions wells located in the core of the plume.

(16) Section 1.6 Preliminary Failure Modes and Effects Analysis (FMEA), 1st paragraph, page 13. Please delete the first sentence beginning AAs with most CERCLA actions....≅ It is not necessary to introduce the idea that additional data are needed to develop a workable design. Perhaps this opening sentence could be replaced with AAs with some responsible party RI/FS leads, the FS prepared by KUCC was incomplete requiring additional data collection in order to develop a workable design.≅

The wording in the first sentence is taken from the EPA guidance document for RD/RA activities. You indicate, "It is not necessary to introduce the idea that additional data are needed to develop a workable design." However your suggested language contradicts this statement by suggesting that "…the FS prepared by KUCC was incomplete requiring additional data collection in order to develop a workable design." Therefore, KUCC intends to leave the language as it is written in the draft.

(17) Section 1.6 Preliminary Failure Modes and Effects Analysis (FMEA), 1st paragraph, page 13. Please make the following corrections in the last sentence. Under item (a) please change

Acould≅ to may. Under item (b) please place identified before Aeffects,≅ and (c) place identified before Aadverse.≅ The FMEA process cannot determine all possible outcomes or effects associated with a failure or even all the failures that are possible.

We understand that the helping verb "could" implies that the predicate is a possible (i.e., conditional, based on physical conditions and events) outcome, whereas the verb "may" implies that the predicate is a matter of volition or permission. We consider that "could" is the proper verb. Item (b) already has "identified" present by implication (see the word "identify" immediately before the series (a), (b), (c)). There is no intent or necessity that the FMEA address all failures or effects. Because it is an "expert-based" approach, it aims to identify the likely and the most consequential impacts. Through the iterative review process (Work Plan – Preliminary Design – Final Design), we consider that there is ample opportunity for members of the TRC, as well as the KUCC team itself, to identify additional important failure modes that need to be considered. To date (i.e., through the review process for this Draft Work Plan) only one additional failure mode has been identified that needs to be added. (Please see response 20 below with respect to "improper placement of well(s)" and the new failure mode of loss of availability of treatment works.)

(18) Section 1.6 Preliminary Failure Modes and Effects Analysis (FMEA), 2nd paragraph, page 13. In the 2nd sentence please place known before Auncertainties.≅ The FMEA process cannot determine all the uncertainties associated with the project.

Your suggestion of adding "known" before "uncertainties" will be incorporated into the Final Remedial Design Work Plan.

(19) Table 1-1 Groundwater Collection and Containment System - Extraction rate does not contain plume, page 15. The Failure Mode should be retitled as AExtraction rate does not contain or reduce the plume.≅

The wording of the selected remedy does not require that the plume be "reduced" (Section 1.5, p. 12 of the Draft Work Plan). The remedy requires that the plume be ***contained (bullet 4)*** and that KUCC ***withdraw the heavily contaminated waters from the core of the acid plume (bullet 5)*** . As the plan clearly involves withdrawal from the core of the plume (such withdrawal already is underway as part of the continuing scale-up activities), the remaining requirement is containment, as stated. In fact, the plume is being reduced as a consequence of extraction. For every gallon of water extracted from the plume, the mass of the plume is ***reduced*** by a finite quantity.

(20) Table 1-1 Groundwater Collection and Containment System - Extraction rate does not contain plume, page 15. Other potential AFailure Modes≅ need to be identified and included. For example, remedy failure due to improper placement of extraction wells is not included. This could be a Failure Mode in and of itself with the adverse effects potentially including some of the

same components of the other identified failure modes, i.e., too little aquifer yield, impact on the draw downs to or from other wells nearby, ineffective containment, etc. Another example would be the failure of the treatment plant(s) and shutdown for a prolonged period of time for maintenance, etc.

KUCC disagrees that the first example represents an additional failure mode. The only sense in which one could say that a well is "improperly placed" would be that the well does not perform adequately to support the entire system in its goal to contain the plume and remove contaminated water. This failure mode already is identified. Inability to manage extracted waters in the treatment plant will be added as recommended.

(21) Table 1-1 Groundwater Collection and Containment System - Delivery pipeline fails, page 15. The Failure Mode should be retitled as AFeed water pipeline fails.≅

Although KUCC does not see any ambiguity in the current wording, it will be changed from "delivery" to "feed-water".

(22) Table 1-1 Water Treatment (NF and RO) and Hydraulic Delivery Systems - Larger volumes than anticipated require treatment and distribution, page 16. Under APossible Mitigation,≅ please explain how adding additional residential handling capacity can mitigate the larger volumes of water needing treatment. Please provide a mitigation plan if the rate of the aquifer cleanup is compromised.

Both mitigation steps (1) and (2), as written, would be needed, the former to manage the mass balance of contaminants, the latter to manage the water balance through the entire system.

Mitigation plans, like monitoring plans, are an outcome of the Remedial Design process, not a component of a work plan. If mitigation (what we have called "contingency") plans are shown by the Remedial Design process to be necessary, they will be prepared in conjunction with the Final Design.

(23) Table 1-1 Treatment of Water-Treatment Concentrates in KUCC Tailings Circuit - Mechanical failure of tailings pipeline, and Tailings circuit does not adequately control chemistry, page 17. If copper production is curtailed, then a short-term mitigation plan to dispose of the increasing treatment concentrates needs to be provided. The disposal method must be in compliance with the ARAR's listed in the EPA ROD. Currently KUCC has not defined the long-term mitigation strategy if the tailings line is not capable of treating the concentrates. The long-term mitigation plan needs to be defined and provided for agency approval.

See comment 20 above on additional failure mode for unavailability of treatment components. Again, long-term mitigation plans, contingency plans, etc. are products of the Remedial Design, itself not developed within the work plan. The work plan lists as a deliverable, a preliminary design for post mining remediation, which will be prepared as part of the Final Remedial Design. The preliminary design for post-mining remediation will contemplate different scenarios such as interruption of tailings productions (for a few days), temporary shutdown of mining facilities (labor unrest, unfavorable economic conditions, catastrophic equipment failure, etc.) for a few months to a few years, and permanent cessation of mining activities.

As discussed in Section 3.1.2.1 on page 25 and Section 3.1.2.3 on page 27, the long-term mitigation plan needs to include the analysis of what impact additional waters from other mining sources will have on the tailings circuit as a treatment unit. This additional study on the tailings pipeline will need to determine if the tailings line can handle the proposed flow rates and if the current tails can neutralize the concentrates, in conjunction with the addition of other mine waste waters. Please appropriately revise all other sections (i.e., Section 3.1.2.1 and Section 3.1.2.3 on pages 24-26) where the tailings line feasibility study is discussed.

Other mining sources already report to the process circuit (and have done for many years) and, therefore, already are implicit in the work plan as written. The only new source is the water-treatment concentrates. We agree, of course, that the mine-water flows must be accounted explicitly and quantitatively in the analysis. We consider that the point UDEQ raises is addressed in items (a) and (b) of 3.1.3.3 (p. 29 of the Draft Work Plan) and in more detail in Attachment 1, particularly items 1, 2, and 6 of the Technical Approach and tasks 1,2, 3, 5,7, 8, and 9 of the Generalized Scope of Work.

The Final Work Plan will include additional detail on the KUCC approach to long-term water management. However, as discussed above, mitigation or "contingency" plans are products of the Remedial Design, not parts of the work plan that initiates the studies needed to develop final designs and plans.

(24) Table 1-1 Treatment of Water-Treatment Concentrates in KUCC Tailings Circuit - Metals and metalloids not irreversibly removed in tailings solids, page 17. If the text is suggesting that the metals or metalloids cannot be removed, then the wording under AFailure Mode≅ needs to be changed to the following: AMetals and metalloids cannot be removed in tailings solid.≅ The phrase Anot irreversibly≅ is a double negative and hence a contradictory statement.

We do **not** suggest that metals cannot be removed, and the double negative is not contradictory. "Irreversibility" (like "reversibility") is a technical term with specific meaning in thermodynamics. "Irreversible" metal removal means that the metals (or metalloids), once precipitated or sorbed from the aqueous to the solid phases (which certainly will happen in the pipeline), would not re-dissolve or desorb back to a different aqueous phase in the tailing environment at some point in the future. The issue is addressed through items 5, 6 and 7 of the Technical Approach outlined in Attachment 1.

(25) Table 1-1 Treatment of Water-Treatment Concentrates in KUCC Tailings Circuit - Tailings acidified, page 18. A long term mitigation plan for Aadverse water quality impacts to ground water and surface water discharge,≅needs to be provided. Mitigation for regulatory and permitting impacts also needs to be provided.

Mitigation plans are outcomes of the Remedial Design, not inputs to the planning process that is represented by the Work Plan.

(26) Table 1-1 Treatment of Water-Treatment Concentrates in KUCC Tailings Circuit - Water quality not suitable for discharge to GSL at end of mining, page 18. Please explain what kind of land application would be proposed for treatment concentrates.

Details of an appropriate "land application" (were that to be selected during the Remedial Design as a mitigation technique) can only be defined after study. Please note that, especially at this early stage in the process, "Failure Modes" are entirely hypothetical; in fact, **all** of the failure modes – by definition – are low to very low probability occurrences, even at this stage. (In no sense are they "predictions" by KUCC of conditions that are expected to exist at any point in the future.) It may be that the performance of the system will be such that water quality would be suitable for discharge, in which case no mitigation is needed, hence, the reason for the studies outlined in the work plan.

(27) Table 2-1 South Facilities Technical Review Committee, page 21. Please note that Mr. Tom Munson has been listed twice on the table.

The table will be edited as noted.

(28) Figure 2-1 KUCC South Facilities RD - Project Organization, page 22. Please indicate who is responsible for permitting issues.

Technical information for the various permits will be obtained from the entire team. However, Jon Cherry will be responsible for environmental permitting issues. The project organization schematic will be modified to reflect permitting responsibility.

(29) Section 3.1.1 Purpose, Scope and Objectives of the Design, 1st paragraph, page 23. It states in the last sentence that an overview of the conceptual design of the remedy was presented in Section 1.4 and Section 1.5. UDERR points out that Section 1.4 describes only the problem and not the conceptual design, and Section 1.5 generally describes the remedy as it is described in the Record of Decision (ROD) and contains no design elements, conceptual or otherwise. Please delete this sentence or reword it to indicate the true content of Sections 1.4 and 1.5.

The sentence will be reworded as follows: "The general nature of conditions that need to be managed is presented in Section 1.4. Section 1.5, EPA's statement of the remedy, identifies the need for containment and extraction of contaminated groundwater, subsequent treatment of contaminated waters, and disposal of the water-treatment concentrates in a manner that will be protective of human health and the environment".

(30) Section 3.1.1 Purpose, Scope and Objectives of the Design, 2nd or 3rd paragraph, page 23. Please indicate that during RD the incomplete FS components will be completed. Also, please note that UDEQ has deferred specific NRD technical informational needs, to be resolved during the RD activities.

The FS is complete. Certain studies identified in the FS were deferred to the Remedial Design process with agreement from the TRC and will be listed as such in Section 1.1 of the Final Remedial Design Work Plan. See comment No. 1 under specific comments.

(31) Table 3-1 Annual Groundwater Extraction Volumes - Zone A, in Section 3.1.2.1, page 24. For ease of understanding, please provide a map showing well locations. Please explain which well is #1201.

Table 3-1 will be revised to include a schedule of specific wells, locations and periods during which the wells will be pumped. A corresponding map also will be provided.

(32) Section 3.1.2.1 Ground water Containment and Extraction System, 5th paragraph, page 24. Item (a), references currently planned volumes of extraction and indicates that in order to contain the plume, greater volume extractions are needed (etc.) Please identify the basis for the currently planned extraction volumes and explain why the current design wasn't prepared with the end goals mentioned in item (a).

"Failure modes" identified in an FMEA are entirely hypothetical conditions. The planned extraction rates are those that flow from the existing analysis (which, therefore, is the design basis). However, by using the FMEA approach we acknowledge the possibility that higher extraction rates may be needed. Whether higher extraction rates are necessary is entirely an empirical matter that will be determined by operational experience in the future.

(33) Section 3.1.2.2 Water Treatment (NF and RO) and Hydraulic Delivery System for Treated Water and Concentrate, 1st paragraph, 3rd sentence, page 25. Please explain why there is another proposed RO unit for treatment of the NF permeate stream, beyond the proposed Bingham Canyon Plant (proposed RO plant for Zone A from the NRD proposal). This is inconsistent with the NRD proposal which states that the NF permeate will be sent to the Zone A RO - Bingham Canyon plant.

In order for the NF permeate to meet acceptable influent conditions to the Zone A RO plant; it must first be pretreated through a RO membrane (or other pretreatment), which might be physically located at the tail end of the NF plant. This is an issue that will be worked out as part of the preliminary and final designs.

(34) Section 3.1.2.3 Management of Water Treatment Concentrates (NF and RO) in KUCC Tailings Circuit, 3rd paragraph, page 26. It is indicated that KUCC can effectively treat only 2/3 of the needed flow rate (67%). Inability to treat 100% of the full scale rate would result in a failure mode that has not been analyzed for. Please identify the probability of effectively treating 100% of the full scale rate, and if it is not possible to do so, how that will be handled in order to still meet the remedy goals, as well as the NRD rebate requirements.

This text will be clarified. It should say that testing already has shown that the existing systems can manage flows at 67% of the expected full-scale rates, and plans already exist to increase the capacity to accommodate the full-scale flows. Should the tailings not contain the required neutralization potential for treatment due to changes in ore type/mineralogy, additional lime will be added to the system to obtain treatment objectives and maintain UPDES effluent discharge limits.

(35) Section 3.1.2.3 Management of Water Treatment Concentrates (NF and RO) in KUCC Tailings Circuit, 7th paragraph, page 27. It is stated that a discharge to the Great Salt Lake of the treatment effluent(s) will occur if the effluent meets UPDES standards. Approval from the Utah Division of Solid and Hazardous Waste's RCRA group may also be needed. Please make this determination and update the RDWP.

There appears to be some confusion as to which concentrate streams are referenced in the context of the direct discharge to the Great Salt Lake. It is the Zone A RO plant concentrate, which is referred to in this context because it has the potential to meet current UPDES discharge limits and will be evaluated as part of the permit analysis described in Section 4. As further explained, KUCC is not currently proposing a direct discharge of the NF plant concentrate stream, or at least not without further treatment. Current modeling of extracted groundwater and subsequent NF Plant concentrate show that the concentrate steam has the potential to exhibit the hazardous characteristic for cadmium (i.e., concentrations greater than 1.0 mg/L) during approximately the first five years of extraction. After that time it is anticipated that the NF Plant concentrate will not exhibit any RCRA hazardous characteristics. Even after 30 years of extraction, the NF Concentrate will likely exceed existing UPDES permitted discharge concentrations and will not be discharged directly to the Great Salt Lake without secondary treatment.

(36) Section 3.1.3.2 Water-Treatment and Hydraulic Delivery System for Treated Water and Concentrate from both NF and RO Units, item #j, page 29. Please explain who KUCC needs to receive a construction permit from for the Zone A treatment facilities.

Technically, KUCC may not require any permit for the construction of the NF and/or the RO plants. CERCLA Section 121(e)(1) provides: "*No Federal, State, or local permit shall be required for the portion of any removal or remedial action conducted entirely onsite, where such remedial action is selected and carried out in compliance with this section.*" However, given certain criteria in the agreements on the NRD project, a construction permit for the RO plant is anticipated as a means of determining a complete and operational date of the plants. The permit analysis and conclusions will be presented the Preliminary Design Report scheduled for completion in October 2001 and certain permits may be sought, even if not required, in view of various circumstances.

(37) Section 3.1.4 Design Deliverables, 2nd paragraph, pages 29 - 30. Monthly progress reviews should be held with both EPA and UDEQ, and reviews could be initiated by EPA and UDEQ at any time. Please revise.

Your comment is noted and the text will be revised accordingly.

(38) Section 4.1 Permit Requirements Plan, 2nd paragraph, page 31. It should be mentioned here that this action is being performed under CERCLA, and pursuant to a three-party agreement between the State of Utah, EPA, and KUCC (dated September 27, 1995). Under that three-party agreement, the state maintains Ajurisdiction over the efforts to control discharges from the Bingham Canyon Mine waste rock and other KUCC facilities covered by state groundwater permits." Such facilities include the tailings lines, RO treatment discharges, etc. Permits are required as they were anticipated, to control ongoing activities at KUCC (as contemplated by the three-party agreement) and not because of the Aunique nature of this project." Please amend the text to indicate that this action is being conducted under the three-party agreement which includes the use of state groundwater permits.

The MOU does state that DEQ agrees to "Maintain jurisdiction over the efforts to control discharges from the Bingham Canyon Mine waste rock and other KUC facilities covered by state groundwater permits." The MOU does not address the remedial action for the SWJV groundwater. Rather, the MOU was limited to the RI/FS for the SWJV groundwater and the south end source control measures, which contemplated the eastside collection system, including the Bingham Creek Channel cutoff wall. These facilities are permitted under the Eastside Collection groundwater discharge permit. There is nothing in the MOU concerning the tailings or the RO treatment discharges. Because the groundwater remedial action is not being conducted under the MOU per se, but under CERCLA, permits may not necessarily be required, but may be sought, as explained in KUCC's response to comment 36 above.

Please review the above responses to the UDEQ and DNR comments and call me if you have any questions, concerns or need further clarification. KUCC will proceed with editing the draft Remedial Design Work Plan and will submit a final draft of the Redial Design Work Plan to EPA, UDEQ and members of the TRC in August 2001.

Sincerely,

Jon Cherry
Senior Project Engineer

Cc: Eva Homman - EPA

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Kennecott

August 3, 2001

Mr. Mark Wichman, P. E.
U.S. Army Corps of Engineers
215 North 17th Street
Omaha, NE 68102-4978

Re: Response to USACE Comments on *Draft Kennecott Utah Copper South Facilities Groundwater Remedial Design Work Plan*, dated April 6, 2001

Dear Mr. Wichman:

Thank you for your review of the draft work plan identified above. The purpose of this letter is to provide a response to your comments and questions and indicate how those issues will be addressed in the revised work plan. Each of your comments is listed below in italics followed by KUCC's response.

1. *Table 1-1, page 15 of 40. Another widely used mitigation for delivery pipeline failure is to locate the pipeline hydraulically up-gradient of the extraction wells.*

Your comment is noted. All of the planned extraction wells will be located downgradient from the Zone A concentrate delivery pipeline. This will be reflected in Table 1-1.

2. *Paragraph 3.1.1, page 23 of 40. The proposed design is expected to be primarily performance based. Performance based specifications typically imply several vendors are available, with similar unit processes, to competitively bid for the remedial action contract. I believed KUCC was adapting/developing the membrane technologies to treat this atypical waste stream. In this case, wouldn't a definitive design package be more appropriate?*

In this case, the performance requirements fall on KUCC itself, but already have been resolved through the long-term technology development and testing program that remains underway. The performance-basis approach, as a practical matter, applies largely to the groundwater extraction and process-system treatment portions of the unified remedy.

3. *Table 3-1, page 24 of 40. The totals in both gpm and acre-feet do not match the extraction rates presented. Please clarify.*

This table will be updated in the Final Work Plan to reflect the latest estimated extraction schedule.

4. *Figure 7-1, page 40. Revise the project schedule to incorporate actual dates for completed tasks.*

The project schedule will be updated periodically, and those updates will include actual dates as they are determined.

Sincerely,

Jon Cherry, P.E.
Senior Project Engineer

Cc: Eva Hoffman – EPA
Doug Bacon – UDEQ

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August 3, 2001

Mr. Bert Stolp
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Salt Lake City, Utah 84119-2047

Re: Review of Draft Kennecott Utah Copper South Facilities Groundwater Remedial Design Work Plan

Thank you for your review of the draft work plan and providing on behalf of the USGS. The purpose of this letter is to provide a response to your comments and questions and indicate how those issues will be addressed in the revised work plan. Each of your comments is listed below in italics followed by KUCC's response.

The primary purpose of a monitoring plan should be to optimally detect (detect as early as possible) when field conditions deviate from predicted conditions (as per ground-water flow simulations). Monitoring should probably be concentrated in areas where steep chemical and hydraulic gradients exist. Temporally, monitoring intervals should be more frequent at the beginning of an introduced stress on the hydrologic system (introduction of a pumping, change in pumping, clean-water injection), and possibly less frequent as the system reaches some new pseudo steady state.

We agree with your comments and will incorporate these and other suggestions into the Remedial Design Monitoring Plan. From past aquifer test experience, we have identified areas that are more sensitive to changes in groundwater extraction rate. These areas will be monitored more frequently than other areas that did not respond. The plan will incorporate enough flexibility that monitoring frequency can be increased or decreased based on monitoring results.

A formal sensitivity analysis of the current Southwest Jordan Valley (SWJV) ground-water flow model could be very insightful in design of a monitoring plan. The current model would need to be converted to MODFLOW 2000, which contains sensitivity/parameter estimation functionality. Once converted, sensitivity of simulated drawdown (geometry and amount) can be measured against hydraulic conductivity values, storage values, aquifer geometry, consolidated-rock inflow, and areal recharge. In this way predicted drawdown is evaluated in a context of individual aquifer characteristics. If drawdown is sensitive to parameters values that are not well understood or have poor spatial constraint, then a monitoring plan should incorporate more frequent sampling. If on the other hand, predicted drawdown is sensitive to a set of parameters that are clearly understood, then a higher level of confidence in the predictive simulations would be justified.

Sensitivity information will also be useful during the remediation process. As time-series data describing aquifer performance (water levels, water-quality, etc) becomes available, very likely some areas or portions of Zone A will react significantly different than predicted. In context of the flow model, sensitivity data is useful in determining which aquifer characteristics have the largest influence on the mathematical solution. Those characteristics should be given special attention (i.e. additional study) if the remedial process begins to deviate from predicted results.

The suggestion for evaluating the sensitivity parameters with regard to the monitoring plan is a reasonable one and something that is being investigated. A formal sensitivity analysis should provide a better understanding in areas where the model may be lacking, and would be helpful in identifying where additional monitoring might be needed. The model is currently being updated for incorporation into GMS 3.1 (Modflow 96). Gaining familiarity with Modflow 2000 and its enhanced features for sensitivity and parameter estimations is underway.

Some additional consideration should also be given to the density aspects of Zone A. During the RI/FS process, density was discussed as it pertained to plume movement. In the particular case of the remedial action, dense water will be removed from the aquifer. This is opposite of the salt-water intrusion problem, where fresh water is being pumped. To successful optimize well-field geometry and pumping rates, it would seem that density induced flow should be considered. It would be equally important if clean-water injection were to be used for plume containment. Rough estimates of density effects can be made by comparing density ratios to the total hydraulic gradient (both horizontal and vertical). A more comprehensive approach could incorporate hypothesis testing using a 2-dimensional vertical slice density model.

There is a potential for density-driven flow to alter the current model estimates of plume migration. As per previous discussions, the incorporation of the ability to simulate the aspect of density-driven plume movement is underway (via GMS and FEMWATER).

Another aspect that should be considered is examination of the patterns and amounts of recharge that are being used in the predictive model simulations. I do not recall the exact method by which recharge was projected into the future, presumably it was based on long-term average annual precipitation rates. It would be a useful exercise to simulate some large (2-4 fold) increase in annual aerial and consolidated-rock recharge. How does this influence plume movement, and could plume containment be jeopardized? Other simulations might include changing land-use and cessation of irrigation-canal use. Obviously a ground-water system dampens any climatic variability. Using the current ground-water flow and transport models, some quantification of that dampening could be made. Having that information, judgments can be made concerning how quickly contingency plans might need to be implemented.

Study of the model's sensitivity to variations in recharge will be done to investigate potential effects on plume migration. This likely would be done in coordination with the previously-mentioned sensitivity analysis. Potential land-use changes that might affect plume migration and/or containment in the model will also be investigated.

As addressed in the RD Work Plan, the KUCC tailings circuit is a critical component of the remedial action. Attachment A outlines a comprehensive plan to quantify the tailings circuit geochemistry. Questions concerning the tailings circuit are threefold, 1) precipitation of solids out of tailing waters, *2) the long-term stability of the precipitates, and 3) effluent discharge to Great Salt Lake. As mentioned in the attachment, these components of the circuit must be considered in terms of transient conditions. The amounts and type of concentrate stream coming from treatment of Zone A water can change over time, as well as the mineralogy of the tailings line itself (as a function of the ore body). Probably the most important factor is the eventual closure of the mine. Since some component of tailings water will eventually discharge to Great Salt Lake, these questions might best be considered in that context. What will be the quantity and quality of discharge to Great Salt Lake be under various operational conditions. In addition, State agencies should understand 1) the dispersion of tailing circuit effluent, 2) the geochemistry of the effluent water within Great Salt Lake, and 3) the biological pathways, risks, and components associated with the effluent stream*

Under normal mining operations discharges from the tailings impoundment to Great Salt Lake are permitted under an existing UPDES discharge permit with corresponding contaminant discharge limitations. Regardless of variations in the operating conditions of the mine, KUCC is obligated to meet the permitted discharge limits applicable at the time in question. The entire remediation system during active mining operations is based on meeting the UPDES effluent discharge limits following extraction and treatment of contaminated groundwater from the mine. The majority of your concerns are addressed and can be found in the Statement of Basis in the recently renewed UPDES permit (Permit No. UTD0000051). If the Zone A RO concentrate is found to be acceptable for discharge to Great Salt Lake, it will be permitted under a modification to the existing UPDES permit or a separate permit will be obtained depending on the discharge location.

KUCC recognizes that after active mining operations have ceased, additional treatment and water management will be required to achieve future permitted discharge limitations. Until such time, the existing UPDES permit discharge limits will be the target. It appears that post-closure discharges would not be subject to the ore mining and dressing limitations, which pertain to active mining operations. While the post-mining RO/NF concentrate discharges to jurisdictional waters of the State would not be subject to the ore mining and dressing effluent limitation guidelines in 40 CFR Part 440, any such discharges would be subject to other applicable limitations consistent with the relevant permitting program.

The majority of your comments in the above paragraph are more related to long-term closure issues for which KUCC will prepare preliminary post closure remedial design plan as part of the overall Final Remedial Design scheduled for completion in December 2002.

The RD Work Plan outlines what I consider an adaptive remedial action. Any such plan must, by definition, be based on comprehensive monitoring of the remediation. Monitoring in turn should be based on the sensitivity of and amount of stress placed on the system. To allow for adaptation, the RD Work Plan suggests quarterly progress meeting with responsible parties and regulators. A written report (not just meeting minutes) describing in particularly any significant findings and corrective measures should accompany these meetings. The reports should have some form of technical or peer review.

The monitoring plan, which is currently being developed, will be designed to evaluate the effectiveness of the containment and extraction strategy that has been selected as the preferred remedial alternative. Part of the monitoring plan will outline the structure for reporting monitoring results. KUCC anticipates reporting water level and quality information on an annual basis. This will not preclude review of the data on a more frequent basis and presentation of relevant data at quarterly communication meetings. These presentations will be distributed with the meeting minutes. KUCC anticipates that peer review of quarterly findings would be in the form of comment and response to these presentations.

If you have any question regarding the above responses to your comments, please call me at 801-569-7128.

Sincerely,

Jon Cherry, P.E.
Senior Project Engineer

Cc: Doug Bacon, UDEQ/DERR
Eva Hoffman, EPA

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August 3, 2001

Mr. Chuck Williamson
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Salt Lake City, Utah 84114-6300

Re: Responses to Comments on the KUCC South Facilities Draft Remedial Design Work Plan

Dear Mr. Williamson:

Thank you for your and Mr. Manning's review of the subject work plan. Your comments were very useful and reflected similar questions and concerns raised by other reviewers. The purpose of this letter is to provide a response to your comments and questions and indicate how those issues will be addressed in the revised work plan. Each of your comments is listed below in italics followed by KUCC's response.

1. *Although reduction of pumping and installation of injection wells have been listed as potential mitigation strategies for water level declines (Table 1-1, Section 3.1.2.1 and 3.1.3.1), there is not mention of how damage (ground subsidence, increased pumping costs, deepening of wells, etc.) resulting from excessive aquifer drawdown will be addressed. As part of the work plan, we believe that Kennecott needs to develop a system whereby legitimate claims of damage by affected property and water right owners will be addressed.*

   As you are aware, aquifer levels in the area have steadily been decreasing since the late 1980s, prior to remediation program pumping. Kennecott, along with many other groundwater pumpers, has already been adversely affected by the decreasing aquifer levels. Kennecott owns senior groundwater rights that have been impaired by the over-pumping of water users with priorities junior to Kennecott. The excessive aquifer drawdown that has taken place in the last 20 years has nothing to do with the proposed remedial pumping project. Kennecott believes it is inappropriate for the State Engineer to suggest that the excessive aquifer drawdown that has occurred in the last 20 years and that will occur in the future is the responsibility of Kennecott. It is important to remember that the sulfate containment wells to be used in the remedial pumping are the same wells currently being used to supply water to the Copperton Concentrator under senior vested rights. Kennecott agrees that if there are legitimate claims of damage by affected property and water right owners resulting from the remediation that those claims will need to be evaluated and addressed by Kennecott.

Kennecott and all of the other groundwater pumpers in the basin will require the assistance of the State Engineer to stabilize the decline of the aquifer. Kennecott has enough senior water rights to extract the volume of water required for the remediation project. However, Kennecott will be looking to work with the State Engineer to cooperatively address the issue of less senior water rights in the area that may be aggravating the continued aquifer drawdown.

2. *Page 15, Table 1-1, What would the mitigation strategy be if the second and third failure modes occurred simultaneously?*

   Kennecott believes that, if the second and third failure modes occurred simultaneously (extraction rate does not contain plume and extraction rate creates an overdraft on the aquifer), the first priority would be to contain the plume. If containing the plume created an overdraft situation, that mode could be mitigated by importing supplemental water. However, if the plume were not contained, the mitigation (if any were possible) would not be as simple as importing supplemental water.

3. *Page 5, last paragraph. The potentiometric surface of the principle aquifer is typically nearer to the surface in the center of the valley rather than at the base of the Oquirrh Mountains as indicated here.*

   The term "center of the valley" is misleading in the text and is referring to the area approximately half way between the Jordan River and the Oquirrh Mountains. The text will be reworded to clarify this statement.

4. *Page 8, third paragraph. It is noted that in spite of high horizontal hydraulic gradients, the plume has extended to considerable depth. What is the relative magnitude of the vertical hydraulic gradient? And could this explain the vertical distribution of contaminated groundwater?*

   The ratio of horizontal hydraulic conductivity (K_h) to vertical hydraulic conductivity (K_v) in the region near the Acid Extraction well where the high-sulfate, low-pH plume resides is about 25:1, (KUC 1998, RI report, table 3-3). In the area near the Bingham Creek Reservoir where the low pH plume originated, this ratio is probably similar. This ratio means that resistance to groundwater flow is 25 times more in the vertical direction than the horizontal direction. Under normal groundwater flow conditions, groundwater would flow outward instead of downward, but we know that for 30 years the water table was mounded with low-pH water leaking from the Bingham Creek Reservoir. The mound would have increased the hydraulic head in the upper portion of the aquifer in the immediate area of the reservoir to such a high degree that the downward vertical gradient was very much higher than it is today. Add to this the increased pressure head due to the higher density of the water because of the high dissolved solids content, and there probably was enough head to force the high-TDS water into the lower portions of the aquifer. Once there, it could flow mostly in a horizontally direction to where it is today. The vertical hydraulic gradient in the Acid Well region today, calculated using water levels in multiple completion wells corrected for high-density water, is actually upward (KUC 1998, RI report appendix F, attachment F-2). Overall, there should be little downward groundwater flow of high-density water occurring today.

5. *Page 21, Table 2-1. Tom Munson appears twice on this list and the SL CO. Health Department (affiliation number 23) is now know as the Salt Lake Valley Health Department.*

   Your comments are noted and the appropriate changes will be made in the final version of the work plan.

6. *Page 24, Table 3-1. The individual extraction rates and annual extraction quantities do not add up to the totals shown at the bottom of this table. If there are additional proposed withdrawals, they should be shown within this table.*

   In the final version of the work plan, this table will be replaced with a more detailed extraction schedule that will show which wells are extracting certain volumes of water during given periods of time over the next 30 to 50 years.

7. *Page 28, Section 3.3.1; Page 31, Section 4.0. No mention is given regarding applying and/or receiving approval for additional water rights necessary for the implementation of this project.*

   The majority of water rights necessary to extract the contaminated water have been approved for that purpose under a change application. Keep in mind that the sulfate containment wells are the current production supply wells for the Copperton concentrator. However, if additional water rights are required for the remediation project, they will be obtained through a transfer application process from other Kennecott water rights located at the mine. The text of the work plan will be clarified to reflect the status of water rights related to current and planned extraction volumes.

8. *Page 33, Section 4.2.4. The State Engineer may only restrict withdrawals based upon the priority date of the respective water rights in the area rather than simply restriction use of valid water rights at existing well locations. The State Engineer has proposed limitations on new appropriations and change applications within the area of concern. Additionally, at the end of the first sentence. This should read "Division of Water Rights" rather than "Department of Water Resources".*

   Kennecott fully supports the State Engineer in efforts to limit new appropriations and change applications in the area of concern. Based on the water right priority date, Kennecott believes the State Engineer should begin the process of restricting withdrawals in the area of concern. Kennecott has data that would indicate that others have already over drafted the aquifer that have priority dates junior to Kennecott. This situation will only become more complicated in the future.

Where appropriate the final draft of the RDWP will be edited to reflect your comments. If you have any questions regarding KUCC's comments, please call me at 801-569-7128.

Sincerely,

Jon Cherry

Jon Cherry, P.E.
Senior Project Engineer

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Kennecott

August 3, 2001

Ms. Michelle Baguley
Grant Administrator HRRR
6120 West 13100 South
Herriman, UT 84065

Re: Responses to Comments on the KUCC South Facilities
Draft Remedial Design Work Plan

Dear Ms. Baguley,

Thank you for your review of the draft work plan and providing the collective comments of Herriman Residents for Responsible Reclamation (HRRR). The purpose of this letter is to provide a response to your comments and questions and indicate how those issues will be addressed in the revised work plan. Each of your comments is listed below in italics followed by KUCC's response.

1. *Page 5 - Groundwater Extraction... I was curious as to why West Jordan decreased their afy extraction by almost one half?*

West Jordan began extracting culinary water from an area adjacent to KUCC's well field in the 70s with one well. In the late 1980s and early 90s, West Jordan was extracting up to approximately 7000 acre feet per year from four wells in the area. KUCC has been extracting industrial water from the same aquifer since the 1960s and the additional West Jordan extraction caused a large sink or water level drop in the region. Since KUCC's water rights are senior to West Jordan's water rights, KUCC would be entitled to the water before West Jordan and therefore West Jordan reduced their extraction rate.

2. *Page 6 - If studies done in 1991 and 1996 indicate that more groundwater is being removed from the principal aquifer than is being supplied by natural recharge, it seems almost certain that pump and treat will severely impact local water resources.*

Currently KUCC has two main sulfate extraction wells (K-60 and K-109). These two wells have historically and currently supply the extracted water to the Copperton concentrator at a rate of approximately 3200 gpm. The remediation and extraction plan calls for the water from these two wells to be diverted to the Zone A reverse osmosis plant in approximately 2004. At the same time, the acid well will be pumped at approximately 2000 gpm. The current plant is to approximately balance the system such that the increased pumping in the acid well does not exceed KUCC's vested water rights.

Evaluating the severity of impact to water resources requires analysis of the empirical data obtained when the remedial system is added to the other stresses on the system, combined with an analysis of how the extraction rate affects the natural resource use in the valley. KUCC already has initiated detailed monitoring of water levels and water quality, in advance of beginning any remedial pumping, so that there will be a high-quality, quantitative database against which one can compare future aquifer conditions.

3. *Page 12 - Has KUCC found final remedies for the water rights and other issues indicated in the second and third bullet paragraphs on this page?*

Kennecott is currently workings its way through the process of potentially affected water rights and possible remedies. These issues will be addressed in a contingency plan that is being developed consistent with the ROD.

4. *Page 15 - Block 3 - In my opinion the rank of consequence for overdraft on the aquifer should be high to extreme. What are the possible mitigation responses from the State Engineer? Does this include replacement of resource or compensation of loss?*

As reflected in many of your comments, and those received from others, one of the most significant concerns is overdraft of the aquifer. Kennecott has been working with the State Engineer and has formally requested that the southwest Jordan Valley be closed to further water right appropriations to prevent additional or accelerated aquifer drawdowns as the aquifer already appears to be over apportioned. Mitigation responses for lost water will depend on quantity and quality lost, reason for the loss (lack of natural recharge vs. over extraction), seniority of water rights, cost of mitigation and feasibility of mitigating actions on a case-by-case basis.

5. *Page 16 - Block 4 - Regulatory impact for drinking water supplies...do you have access to alternative source and or, are there other water rights that can be purchased? I am concerned that although the intent is good that the resource just might not be available.*

The Natural Resource Damage Settlement required Kennecott to provide the equivalent volume of drinking water that had been damaged from sulfate contamination. That is the purpose of the Zone A RO treatment plant and the Zone B RO treatment plant. This water will be available to compensate for damaged drinking water. Drinking water wells that are not affected by contamination but are affected by water level declines will be evaluated on a case by case basis including seniority of water rights, potential for drilling a deeper well, potential for providing user a connection to a municipal water supply, etc.

Groundwater resources in the southwestern portion of Salt Lake County are limited. Water rights can be purchased however only limited areas in the remedial and adjacent area have potable groundwater. Purchase of water rights from other areas could be considered but the State Engineer will not likely approve change applications to move groundwater rights into the general area because there is already an over allocation of groundwater resources meaning that there is more "paper" water than "wet" water available. Current replacement culinary water may be supplied from sources outside of the Salt Lake basin such as Deer Creek Reservoir (JVWCD). The JVWCD is currently supplying all or a portion of the culinary water to all municipalities in the affected areas. It is anticipated that they will provide more water to the western reaches of the SW part of the valley as they expand their distribution network.

6. *Page 28 - i)- When will the contingency plan for mitigation of water level declines be available for review?*

At the latest, a draft of the contingency plan for mitigation of water level declines will be included as part of the Draft Preliminary Design scheduled to be provided to the TRC in October 2001.

7. *Page 31 - 4.1 second paragraph...I am very supportive of the plan to create a clean drinking water source for municipal consumption. Let us also remember private well and water rights.*

This issue will be addressed in the contingency plan discussed above.

8. *Page 32 - 4.1.2 - Hurray!!!*

9. *Page 33 - 4.2.2 - Please clarify this paragraph. To whom will the restrictions and moratoriums apply?*

Use restrictions could apply to any water right owner. If the owner attempted to move a water right into an area experiencing significant water level decline, then it should be anticipated that the State Engineer may not approve the change application. Other restrictions may include that existing wells experiencing water quality problems or lack of water and a new well is planned, the new well would be required to be drilled and screened at a deeper depth, isolating the water intake area. It is also anticipated that the State Engineer would not allow any additional water rights to be moved into any of the already over allocated area, thereby establishing a moratorium for any additional groundwater extraction. Additional restrictions may include that any junior priority water rights could be restricted from extracting any groundwater.

10. Page 33 -4.2.4 - Will this keep the City of Herriman from developing additional Water resources for the City? I believe that it is the intent of the City to become a municipal purveyor of water in the near future. In fact I believe that there have been *purchases of undeveloped water rights and also some kind of a working relationship between the city and JVWCD. This is a rapidly growing community and the need for additional water resources is vital.*

Herriman will need to develop water resources as its population grows. The Rose Canyon area is a possible source of water from the alluvial and shallow bedrock aquifers. Herriman can also consider deeper bedrock targets in the upper Rose Canyon area. In addition, the JVWCD is currently supplying water to Herriman and this supply can be increase as demand increases. Undeveloped water rights located in the overdraft or in contaminated areas would be discouraged from development.

Where appropriate the final draft of the RDWP will be edited to reflect your comments. If you have any questions regarding KUCC's comments, please call me at 801-569-7128.

Sincerely,

Jon Cherry

Jon Cherry, P.E.
Senior Project Engineer

Cc: Eva Hoffman
Doug Bacon